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APPENDIX M

100-KR-1 OPERABLE UNIT
FOCUSED FEASIBILITY STUDY REPORT

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COPC	contaminant of potential concern
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
Ecology	Washington State Department of Ecology
EHQ	Environmental Hazard Quotient
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FFS	focused feasibility study
HQ	health quotient
HPPS	*Hanford Past-Practice Strategy*
ICR	incremental cancer risk
IRM	interim remedial measure
LFI	limited field investigation
LDR	Land Disposal Restrictions
MTCA B	*Model Toxics Control Act, Method B*
NEPA	*National Environmental Policy Act of 1969*
O&M	operations and management
PNL	Pacific Northwest Lab
PRG	preliminary remediation goal
QRA	qualitative risk assessment
RI/FS	remedial investigation/feasibility study
UNI	United Nuclear Industries
WHC	Westinghouse Hanford Company

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1.0 INTRODUCTION

This 100-KR-1 Operable Unit Focused Feasibility Study (FFS) is prepared in support of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) process for the 100 Areas. As discussed in Section 1.0 of the Process Document (defined as Sections 1.0 through 6.0 and Appendices A, B, and C of the *100 Area Source Operable Unit Focused Feasibility Study*), the approach for the RI/FS activities for the 100 Areas has been defined in the *Hanford Past-Practice Strategy* (HPPS) (DOE-RL 1991). The HPPS emphasizes timely integration of ongoing site characterization activities into the decisionmaking process (the observational approach) and expedites the remedial action process by emphasizing the use of interim actions. This 100-KR-1 FFS, therefore, evaluates the remedial alternatives for interim action at high-priority (candidates for interim remedial measures [IRMs]) waste sites within the 100-KR-1 Operable Unit, and provides the information needed for the timely selection of the most appropriate interim action at each waste site. The high-priority waste sites were originally defined in the 100-KR-1 Work Plan and further described in the Limited Field Investigation (LFI) and Qualitative Risk Assessment (QRA) (DOE-RL 1992a, DOE-RL 1994a, and WHC 1993).

As shown in Figure 1-2 of the Process Document, the FFS process for the 100 Areas is conducted in two stages: an evaluation of remedial alternatives for waste-site groups (presented in the Process Document) and an evaluation of the remedial alternatives for individual waste sites (presented in the Operable Unit FFS). In this FFS, the evaluation of alternatives for cleaning up individual waste sites uses the previously developed evaluation of alternatives for waste-site groups whenever possible. That is, whenever the characteristics of the individual waste-sites are sufficiently similar to the characteristics of the waste-site groups, the evaluation of alternatives in the Process Document is used. This approach, referred to as the "plug-in" approach, is used because there are many waste sites within the 100 Areas that are similar to each other. This "plug-in" approach is further described in Sections 1.1 and 1.4 of the Process Document. The remedial action objectives and preliminary remediation goals (PRG) that direct the detailed analysis of alternatives in both the Process Document and the FFS are defined in Section 2.0 of the Process Document.

The evaluation of alternatives in the Process Document was conducted by establishing remedial goals based primarily on human health-risk goals assuming an occasional use of the land surface and soil remediation to support frequent use of groundwater. This 100-KR-1 FFS Appendix includes a detailed evaluation of alternatives using these same health-risk based goals and the "plug-in" approach. However, the final land use for the 100 Areas at the Hanford Site has not been established. The public, regulatory agencies, and Hanford Site stakeholders have provided input to DOE regarding future uses, including the Hanford Future Site Uses Working Group (DOE-RL 1992c), and the potential uses are diverse. For the purposes of this FFS, EPA, Ecology, and DOE have agreed to cleanup goals that would not limit future uses of the 100 Areas. This will be accomplished by not considering IRMs that would leave contaminants at the waste site (such as onsite Containment or In Situ Treatment Alternatives), by remediating soils based on the State of Washington's MTCA B regulations for organic and inorganic chemicals, and by remediating the waste sites to meet EPA's proposed standard of 15 mrem/year above background for radionuclides.

The Sensitivity Analysis (Appendix D of this 100 Area Source Operable Unit FFS) evaluated the effects of using different remediation goals than used in the Process Document (for example, goals based on frequent use of land and groundwater). The Sensitivity Analysis also evaluated the effects of using the MTCA B/15 mrem/year based remediation goals on the analysis of alternatives. The information acquired during the Sensitivity Analysis, therefore, is used in this FFS to conduct the comparative analysis of remedial alternatives (Section 6.0), to determine which remedial alternatives are most appropriate for meeting the MTCA B/15 mrem/year remediation goals. The exposure scenario developed to express meeting the MTCA B soil remediation goal and EPA's 15 mrem/year radiological dose level is referred to as the "Revised Scenario" in the FFS. The exposure scenario used in the Process Document (occasional use of the land surface and frequent use of groundwater) is referred to as the "Baseline Scenario." The conclusions reached in this 100-KR-1 FFS regarding IRMs are presented in Section 6.0.

1.1 PURPOSE AND SCOPE

The scope of this document is limited to evaluating IRMs for five of the six sites recommended in the 100-KR-1 Limited Field Investigation (LFI) (DOE-RL 1994a) as IRM candidate sites. The sixth site, the 116-K-3 Outfall Structure, is being addressed under an Expedited Response Action (DOE-RL 1994b). Impacted groundwater beneath the 100-K Area is being addressed in a separate 100-KR-4 FFS (DOE-RL 1994c). The low-priority waste sites and potentially impacted river sediments near the 100 Areas are not considered candidates for IRMs. These waste sites are being addressed under the RI/FS pathway of the *Hanford Past-Practice Strategy* (DOE-RL 1991).

This FFS presents the following:

- The 100-KR-1 Operable Unit individual waste site information (Section 2.0)
- The development of individual site profiles (Section 2.0)
- The identification of representative groups for individual waste sites, a comparison against the applicability criteria, and identification of appropriate enhancements for the alternatives (Section 3.0)
- A discussion of the deviations and/or enhancements of an alternative and additional alternative development, as needed (Section 4.0)
- The detailed analyses for waste sites that deviate from the representative waste-site group alternatives (Section 5.0)

- A comparative analysis for all individual waste sites using the "Revised Scenario" as defined above and developed in the Sensitivity Analysis (Section 6.0).

1.2 INCORPORATION OF NATIONAL ENVIRONMENTAL POLICY ACT VALUES

In accordance with DOE Order 5400.4 and 10 CFR 1021, DOE CERCLA documents are to incorporate *National Environmental Policy Act of 1969* (NEPA) values to the extent practicable. Many NEPA values, such as a statement of purpose and need, description of alternatives for the proposed action (including a no-action alternative), description of the affected environment (including meteorology, hydrology, geology, ecological resources, and land-use), applicable laws and guidelines, short-term and long-term impacts on human health and the environment, emissions to air and water, and cost are typically included in a CERCLA Feasibility Study. Other NEPA values not normally considered in a CERCLA Feasibility Study, including evaluation of potential impacts on cultural resources, socioeconomics, and transportation; consideration of indirect and cumulative impacts, irreversible and irretrievable commitment of resources, and environmental justice; and mitigation of impacts have been incorporated in the Process Document (Sections 3.3 and 5.2).

Several NEPA values common to all of the 100 Area Operable Units, including applicable laws and guidelines, are addressed in the *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL-1993a) and in the Process Document. Furthermore, NEPA values were incorporated into the analysis of remedial alternatives presented in Sections 5.0 and 6.0 of the Process Document.

The NEPA values that are specific to the 100-KR-1 Operable Unit, including ecological and cultural resources, are discussed in Section 2.2 of this FFS. Other NEPA values relative to meteorology, hydrology, and geology are included in background documents that are referenced in Section 2.2. A detailed evaluation of alternatives including costs, is presented in Section 5.0 of this 100-KR-1 FFS, while the alternatives are compared to each other in Section 6.0.

2.0 WASTE-SITE INFORMATION

2.1 OPERABLE UNIT BACKGROUND

The 100 Areas at the Hanford Site are located in Benton County along the southern banks of the Columbia River in the north central part of the Site (Figure M2-1). The 100-KR-1 Operable Unit comprises the northern half of the 100-K Area and is located immediately adjacent to the Columbia River shoreline. The operable unit lies predominantly within Sections 5 and 6 of Township 13N, Range 26E, and Sections 31 and 32 of Township 14N, Range 26E (DOE-RL 1992a).

The 100-K Area contains two separate reactors, the 105-KE and 105-KW Reactors (WHC 1994a). Both reactors are about 500 m (1,640 ft) south of the Columbia River. Several support facilities for both reactors, such as the cooling water retention basins, are located closer to the river than either reactor (Figure M2-2). The 100-KR-1 Operable Unit is one of three operable units associated with the 100-K Area. The 100-KR-1 and 100-KR-2 Operable Units are source operable units. The 100-KR-1 Operable Unit includes the cooling water retention basins for both reactors (116-KW-3 and 116-KE-4), the 116-K-1 Crib and 116-K-2 Process Effluent Trench used for disposal of process effluent water, and the underground 100-KR-1 Process Effluent Pipelines. The 100-KR-2 Operable Unit includes the two reactors, several small liquid disposal facilities, and burial grounds associated with the operation of both reactors. Groundwater below the source operable units in the 100-K Area is being addressed in the 100-KR-4 Operable Unit. The 100-KR-4 Operable Unit also addresses potential contaminant migration to sediments, surface water, and biota in and adjacent to the Columbia River.

The 105-KE and 105-KW Reactors were the seventh and eighth Hanford Site reactors built to manufacture plutonium during and after World War II. Fuel elements for the reactors were assembled in the 300 Area, and the plutonium-enriched fuel produced by the reactors was processed in the 200 Area. The 105-KE Reactor operated from 1955 to 1971, when it was retired. The 105-KW Reactor began operation in 1955 and was retired in 1970. After the reactors were retired, decontamination and decommissioning activities were initiated to minimize the potential spread of radioactive and other potential contaminants. This process is ongoing and many of the structures in the 100-K Area have been demolished.

In the 100-KR-1 Operable Unit, six facilities were identified as high-priority waste sites during development of the Work Plan (DOE-RL 1992a): the 116-K-1 Crib, 116-K-2 Process Effluent Trench, 116-K-3 Outfall Structure, 116-KW-3 Retention Basins, 116-KE-4 Retention Basins, and the 100-KR-1 Buried Process Effluent Pipelines. The 100-KR-1 Buried Process Effluent Pipelines refer to the underground cooling water effluent pipelines within the 100-KR-1 Operable Unit boundaries (Figure M2-2). The 116-K-3 Outfall Structure is part of an expedited response action and is being remediated under that program (DOE-RL 1994b). The remaining facilities are evaluated in this FFS for IRMs.

Since the preparation of the *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL 1993a), additional data have been collected that are relevant to the 100 Areas in general and to the 100-KR-1 Operable Unit specifically. A LFI (DOE-RL 1994a) and QRA (WHC 1993) have been performed for the 100-KR-1 Operable Unit. In addition, aggregate area studies were performed to evaluate cultural resources, area ecology, physical resources, and background issues. The additional data collection activities are summarized in the subsequent sections.

2.2 100 AREAS AGGREGATE STUDIES

Hanford Site studies, such as the Hanford Site Background studies, provide integrated analyses of selected issues on a scale larger than the operable unit. Several studies provide information common to the 100 Areas, covering topics such as river impacts, shoreline ecology, and cultural resources (e.g., Stegen 1994; Landeen et al. 1993; Fitzner et al. 1994; Chatters et al. 1992; DOE-RL 1994d). The 100-K Area source and groundwater operable unit work plans provide detail on the physical setting within the 100-K Area, such as land form, geology, groundwater, surface water, meteorology, natural resources, and human resources (DOE-RL 1992a and 1992b).

2.2.1 Hanford Site Background Study

The characterization of the natural chemical composition of Hanford Site soil samples is presented in *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE-RL 1993b). The background values for inorganic constituents in soils, based on the above report are discussed in Section 2.0 and Appendix A of the Process Document. Background values for radionuclides are currently under evaluation. Many isotopes produced on the Hanford Site are not found in background above levels of detection (see Appendix A of the Process Document).

2.2.2 Ecological Studies

Bird, mammal, and plant surveys in the 100 Areas were conducted and reported by Sackschewsky and Landeen (1992). Conceptual food pathways and inventories of wildlife and plants at the Hanford Site, including threatened and endangered species, were presented by Weiss and Mitchell (1992). Cadwell (1994) described the aquatic species in the Hanford Reach of the Columbia River, the spatial distribution of vegetation types at the Hanford Site, and surveys of species of concern, such as the shrub-steppe vegetation, threatened and endangered birds, mule deer, and elk populations.

The plant communities near the 100-K Area have been broadly described as a riparian community immediately adjacent to the Columbia River and a cheatgrass community away from the river (Rogers and Rickard 1977; Sackschewsky and Landeen 1992). The shoreline immediately upriver of the 100-KR-1 Operable Unit, between the Allard Pumphouse and

100-K Area, is one of the most diverse vegetative communities in the 100 Areas. There are many trees in this area, mostly mulberries, elms, and willows. The area is defined by a peninsula that juts upriver at Coyote Rapids. The peninsula forms a backwater area that functions as an isolated pond during low water periods. This riparian zone provides an array of habitats in a small geographic area.

Near the water line, the plant community is dominated by reed canary grass. Beyond this is a Kentucky bluegrass zone, a thickspike wheatgrass zone, and finally the dryland cheatgrass/Sandberg's bluegrass community. Each vegetation zone has a large number of associated species (Landeen et al. 1993).

The most common animal species is the Great Basin pocket mouse. Other mammals that are known to use the area infrequently include mule deer, coyotes, badgers, black-tailed jackrabbits, and some bat species. Birds that are known to inhabit the area include rock doves, western kingbirds, western meadowlarks, horned larks, house sparrows, common ravens, and magpies. Canadian geese, other waterfowl, and shore birds nest in the wetland sloughs above and below the 100-K Area. Raptors such as red-tailed hawks, Swainson's hawks, and ferruginous hawks have been observed infrequently foraging around the 100-K Reactor site. Reptiles that are known to inhabit the area include the side-blotched lizard, gopher snake, and northern Pacific rattlesnake. Common insect groups include grasshoppers, ants, and darkling beetles.

Bald eagles, a federal and state listed threatened species, are seasonal residents at the Hanford Site, primarily along the river during late fall through early spring. There are several frequently used perch trees at the northwest end of the 100-K Area and several frequently used ground perches east and west of the 100-K Area. Peregrine falcons, a federally listed endangered species, have been observed only infrequently at the Hanford Site. They may use the area as a resting or feeding area during spring and fall migrations, but they do not nest at the Hanford Site. Swainson's hawks, a state and federal candidate species, nest in many of the trees planted in the 1940s. These hawks will return to the same nesting sites year after year. Nesting ferruginous hawks are becoming more common at the Hanford Site (Fitzner and Newell 1989), but most nest south or across the river from the 100-K Area.

Remedial activities in the 100-K Area must be conducted to protect the various ecological communities along the river, as well as to avoid disturbing the bald eagles' feeding and roosting activities during the winter. Guidance on issues dealing with bald eagles can be found in the *Bald Eagle Site Management Plan for the Hanford Site, South Central Washington* (Fitzner and Weiss 1994). Because bald eagles are seasonal residents (late fall to early spring), remedial activities should be scheduled to occur primarily in the summer and early fall.

Other species that could potentially be influenced by remedial work in the 100-KR-1 Operable Unit include the ferruginous hawk, long-billed curlew, loggerhead shrike, burrowing owl, persistent sepal yellowcress, southern mudwort, and two aquatic molluscs (the Columbia pebblesnail and shortfaced lanx). The molluscs could be impacted if erosion caused an increase in sediment loads in the river or degraded water quality.

Cadwell (1994) concluded that intrusive-type remedial activities conducted inside the controlled-area fences will not have a significant impact on the wildlife. Landeen et al. (1993) states that intrusive activities outside the controlled-area fences should have minimal impact on protected wildlife species if the recommendations outlined in the documents listed below are followed:

- *Bald Eagle Site Management Plan for the Hanford Site, South Central Washington* (Fitzner and Weiss 1994)
- *Biological Assessment for Threatened and Endangered Wildlife Species* (Fitzner et al. 1994)
- *Biological Assessment for State Candidates and Monitored Wildlife Species Related to CERCLA* (Stegen 1992).

Ecological surveys should be conducted at waste sites scheduled for remedial actions to document the presence or absence of these species and to determine potential mitigation measures that may be required.

2.2.3 Cultural Resources

Various cultural resource-related investigations have been conducted in the 100-K Area over the last few decades. The investigations include archaeological reconnaissances, systematic surveys, a test excavation, and interviews with Native Americans who have historical ties to the area (Chatters et al. 1992; Relander 1986; Rice 1968, 1980; Wright 1993). These investigations have helped identify several archaeological and ethnohistoric sites in and around the 100-KR-1 Operable Unit that range in age from 9,000 years ago to the mid-nineteenth century. In addition to these known archaeological sites, it is possible that subsurface archaeological deposits exist within the 100-KR-1 Operable Unit, especially within 400 m (1,300 ft) of the Columbia River. This near-river zone is considered to have high potential for cultural resources.

Evaluations of the archaeological sites and ethnohistorical information indicate that the 100-K Area cultural resources are significant. Two of the sites are individually eligible for the National Register of Historic Places (45BN423, 45BN434), while others are included in the Ryegrass Archaeological District, which extends into the 100-KR-1 Operable Unit (45BN149, 45BN150, and 45BN151). Beyond the potential for these sites to yield important scientific information, additional significance is ascribed to sites in the area because of potential associations with events related to Smohalla, Prophet of the Wanapum people. Along the rapids adjacent to the 100-K Area, known to the Wanapum as *Moon* [Water Swirl Place] and to us as Coyote Rapids, Smohalla held the first *washat*, the dance ceremony that has become central to the Seven Drums or Dreamer religion (Relander 1986). This religion spread to many neighboring Tribes and is currently practiced in some form throughout the interior Northwest. Furthermore, a Wanapum cemetery exists in the 100-K Area.

Based on existing information, the 100-KR-1 Operable Unit is considered extremely sensitive for Native American-related cultural resources. These include areas where cultural resources have been identified from surface investigations (the locations of which cannot be released in public documents), and areas where there are no surface indications, yet a high potential for subsurface cultural resources exists. Of particular concern are four of the high-priority waste sites evaluated in this FFS:

- 116-K-1 Crib
- 116-K-2 Process Effluent Trench
- 116-KW-3 Retention Basins
- 116-KE-4 Retention Basins.

While it appears that these areas were disturbed during construction of the reactors and related structures, the horizontal and vertical extent of this disturbance is not known, and it is possible that intact archaeological deposits exist. It is important to incorporate a strategy for the protection of cultural resources, to the greatest extent possible, in decisions related to remedial actions in the 100-K Area because of Native American concerns relative to these potential archaeological sites.

The preference, from a cultural resource standpoint, is to select cleanup strategies and technologies that result in the least amount of disturbance to the earth. However, in many cases, ground disturbance will be required if threats to human health and the environment from contamination must be reduced. It is important to involve the Indian Tribes and others responsible for Hanford Site cultural resources in 100-KR-1 cleanup decisions affecting areas that have high potential for impacting cultural resources. Such involvement will help identify the following:

- The preferred cleanup strategy and technology for each waste site

- The areas that should be investigated for cultural resources before cleanup activities begin (reducing the chance that important resources will be damaged inadvertently)

- The monitoring requirements once ground-disturbing activities commence.

To further identify those waste sites that pose extraordinary risk to cultural resources, cultural resource impact assessments are being conducted for each waste site in the 100-K Area. Assessment scores will be determined and presented in an action plan being prepared for 100-KR-1 by the Environmental Restoration Contractor.

2.2.4 Summary

The potential influence of remedial actions on the resources described in the preceding subsections are considered during the analysis of remedial alternatives conducted in Sections 5.0 and 6.0 of the Process Document and Sections 5.0 and 6.0 of this FFS. Other issues, such as potential transportation and socioeconomic impacts, are discussed in Sections 3.3 and 5.2 of the Process Document. The assessment of potential impacts in the Process Document is consistent with the potential impacts anticipated as a result of remediating the individual waste sites at the 100-KR-1 Operable Unit. Mitigation measures, as discussed in Section 5.2.2 of the Process Document, will be developed during the conceptual and preliminary design of the selected IRM to avoid or minimize impacts on physical, biological, and cultural resources.

2.3 LIMITED FIELD INVESTIGATION

The LFI is an integral part of the RI/FS process and is based on Hanford Site-specific agreements discussed in the following:

- *Hanford Federal Facility Agreement and Consent Order* ([Tri-Party Agreement] Fourth Amendment) (Ecology et al. 1994)
- *Hanford Site Risk Assessment Methodology* (DOE-RL 1995b)
- *Remedial Investigation/Feasibility Study Work Plan for the 100-KR-1 Operable Unit* (DOE-RL 1992a)
- *Hanford Past-Practice Strategy* (DOE-RL 1991) that emphasizes initiating and completing waste site cleanup through interim actions.

The primary purpose of the LFI at the 100-KR-1 Operable Unit is to collect sufficient data relating to the operable unit for recommending which sites should remain as candidates for IRM. Sites that are not recommended for IRMs will be addressed later during the final remedy selection process for the entire 100 Areas. Secondarily, the data gathered in the LFI are used to evaluate remedial alternatives in this FFS.

A QRA (performed as part of the LFI) identifies the principal risk drivers, and provides information to support IRMs at each high-priority waste site at the 100-KR-1 Operable Unit. The QRA presents a qualitative evaluation of risks for a predefined set of human and environmental exposure scenarios, and is not intended to replace the baseline risk assessment.

The QRA considers only frequent- and occasional-use human health exposure scenarios with four pathways (soil ingestion, fugitive dust inhalation, inhalation of volatile organics from soil, and external radiation exposure), and an ecological exposure scenario based on ingestion of plants by the Great Basin pocket mouse.

For the human health risk assessment, frequent- and occasional-use exposure scenarios are evaluated to provide bounding estimates of risk consistent with the residential and recreational exposure scenarios presented in the *Hanford Site Risk Assessment Methodology* (DOE-RL 1995b). The frequent-use scenario is evaluated assuming residential use will occur no earlier than the year 2018, and to estimate the potential future risk associated with each waste site after additional radionuclide decay. For the current occasional-use scenario, the effect of radiation shielding by the upper 2 m (6 ft) of soil on the external exposure risk at each waste site is also evaluated. Currently, there are no such land uses in the 100-KR-1 Operable Unit.

The estimated risks associated with carcinogenic contaminants at 100-KR-1 are grouped into four categories based on lifetime incremental cancer risk (ICR):

- High - ICR $>1 \times 10^{-2}$
- Medium - ICR between 1×10^{-4} and 1×10^{-2}
- Low - ICR between 1×10^{-6} and 1×10^{-4}
- Very low - ICR $<1 \times 10^{-6}$.

The risks associated with inorganic and organic contaminates that produce systemic effects (noncarcinogenic contaminants) are expressed as a hazard quotient (for an individual contaminant) or a hazard index (for several contaminants that have the same effect). Hazard quotients and hazard indices greater than one indicate a health risk is present (EPA 1989).

The ecological risk assessment evaluates contaminant intake by the Great Basin pocket mouse. The mouse is used as an indicator receptor because (1) it is common at the Hanford Site, (2) its home range is comparable to the size of most waste sites so it will receive most of its dose from within an individual waste site, and (3) it lives in close association with soils (where the contaminants are located). Ecological risks are defined by estimating the amount of contaminants received through ingestion of food, and then calculating an environmental hazard quotient (EHQ). An EHQ greater than one (unity) indicates that the contaminant poses a risk to individual mice.

The results of the LFI/QRA are used to select which sites should continue on the IRM pathway. If IRMs are not justified, the site is subject to further investigation and/or remediation under the 100 Areas RI/FS process. The LFI report for the 100-KR-1 Operable Unit describes the field sampling program, identifies the constituents at each site, presents the data analysis, and discusses the risk assessment conclusions for the operable unit (DOE-RL 1994a).

Based on the LFI/QRA, waste sites at the 100-KR-1 Operable Unit are retained as IRM candidates if:

- The site poses a medium or high incremental cancer risk to humans under the occasional-use scenario

- The site contains noncarcinogenic contaminants that exceed a human health hazard quotient of 1.0, or hazard index of 1.0, under the occasional-use scenario

- The site contains contaminants that pose a risk to the Great Basin pocket mouse (EHQ greater than 1.0)

- The site has contaminants at levels that exceed applicable or relevant and appropriate requirements (ARARs) (see Appendix C of the Process Document)

- The site has a probable current impact on groundwater, based on comparing onsite contaminant concentrations to groundwater protection criteria.

The LFI also assumes that solid waste burial grounds are IRM candidate sites regardless of the above criteria. The IRM candidacy review conducted during the LFI evaluation retained six waste sites as IRM candidates (Table M2-1).

Although the outfall structure at the 100-KR-1 Operable Unit is determined to be an IRM candidate site in the LFI, it has been recently designated for an ERA in conjunction with the river effluent pipelines at the operable unit. The *100 Areas River Effluent Pipelines Expedited Response Action Proposal* (DOE-RL 1994b) states that the 100 Areas outfall structure will be addressed concurrently with the river pipelines. The 116-K-3 Outfall Structure is therefore not addressed further in this FFS.

The conclusions drawn from the LFI are used solely to determine IRM candidacy for high-priority waste sites within the 100-KR-1 Operable Unit. While this FFS report relies on the data presented in the LFI/QRA, the conclusions drawn by this FFS are based on the analyses of the remedial alternatives in Sections 5.0 and 6.0 of the Process Document, Sections 4.0 and 5.0 in the Sensitivity Analysis (Appendix D), and this FFS (Appendix M).

2.4 DEVELOPMENT OF WASTE-SITE PROFILES

To facilitate implementation of the plug-in approach described in Section 1.0 of the Process Document, waste-site profiles are developed for each of the five IRM candidate sites within the 100-KR-1 Operable Unit. These five IRM candidate sites are selected from a total of six high-priority waste sites (Table M2-1) within the 100-KR-1 Operable Unit, as discussed in the LFI study (DOE-RL 1994a). Individual site profiles are developed using radiological data from Dorian and Richards (1978), data obtained during the sampling for the LFI, and information acquired during decontamination and decommissioning (D&D) activities. When site-specific data are unavailable, data from analogous sites were used to describe the conditions at 100-KR-1 waste sites, and develop waste-site profiles.

2.4.1 Site Descriptions

The first step in developing the individual waste-site profiles is to prepare a site description of each IRM candidate site (Table M2-2). This includes listing the name of the site, describing its use during the operation of the 100-K Reactors, describing its physical characteristics (the size and structural material), and determining the waste-site group the individual waste site belongs in. The waste-site groups are described in Section 3.0 of the Process Document.

Based on the description of the waste sites in Table M2-2, it is concluded that the 116-K-1 Crib has the characteristics of a process effluent trench. Therefore, the 116-K-1 Crib is evaluated as a process effluent trench in this document, rather than as a crib.

2.4.2 Refined Contaminants of Potential Concern

To develop the individual waste-site profiles, a determination was made of which contaminants present at each waste site posed a risk to humans, biological receptors (plants and animals), and/or groundwater quality. These so-called "refined contaminants of potential concern (COPC)" are the risk-drivers at the site and represent the contaminants that must be remediated. The refined COPCs are identified by starting with the list of COPCs developed during the LFI and then screening these contaminants against more stringent risk criteria.

The COPCs from the LFI (DOE-RL 1994a) are defined as those contaminants that are known to occur within the operable unit or waste site, and are present at concentrations that exceed natural background levels or conservative human risk criteria (ICR > 10^{-7} or Hazard Quotient > 0.1). For example, if strontium-90 is present at soil concentrations above 193 pCi/g, it presents an incremental cancer risk greater than 10^{-7} and is considered a COPC. If strontium-90 concentrations are below this level, the concentrations are considered to be below levels requiring further evaluation, and the contaminant is not a COPC.

The refined COPCs for each IRM candidate site at the 100-KR-1 Operable Unit are identified by comparing the concentrations of the COPCs to the PRGs developed in Table M2-3, and in Section 2.0 and Appendix A of the Process Document. If a maximum COPC concentration at the waste site exceeds the PRGs, then that contaminant is considered a refined COPC. There can be one to several refined COPC at each site, and the number and types of refined COPCs are used to help determine which remedial alternatives may be appropriate at the site. The derivation of PRGs is described in Appendix A of the Process Document. The PRGs represent the maximum concentration of a contaminant that does not exceed an acceptable human health or ecological risk level, or does not exceed the groundwater protection criteria. Table M2-3 presents the PRGs that are developed using the protocol in the Process Document. The PRGs are not set at concentrations below natural background concentrations to preclude trying to remediate naturally existing constituents in soils. Also, if the risk-based PRG is less than the laboratory required quantification/ detection limit for a particular contaminant, then the quantification/detection limit is used as the PRG (for example, the PRGs for carbon-14 are both 50 pCi/g even though the groundwater protection criteria is 18 pCi/g, because 50 pCi/g is the detection limit, Table M2-3).

Two or more PRGs are determined for each COPC as shown in Table M2-3. All COPCs have PRGs that represent a concentration protective of groundwater, and almost all COPCs have PRGs based on human health risks assuming a recreational exposure scenario. The PRGs for the carcinogenic radionuclides and chemicals represent the soil concentration that poses an ICR of one in a million. The human health PRGs for noncarcinogenic chemicals represent the concentration that results in a hazard quotient of 0.1. For a given contaminant, the most stringent PRG is used, and is applied at different depth strata depending on whether human and biological receptors would be exposed or protection of groundwater is the main factor. For example, for cobalt-60 the most stringent PRG is the one in a million ICR level (soil concentration of 17.5 pCi/g). This PRG (17.5) is applicable at the 0 to 3 m (0 to 10 ft) depth strata because (1) humans are exposed to contaminants within the 0 to 1 m (0 to 3 ft) strata (assuming recreational exposure scenario) and (2) the human health-based PRG is used at depth strata where animals and plants (0 to 3 m [0 to 10 ft]) are exposed because there is no ecological-based PRG available for cobalt-60 (i.e., the human health PRG is used as a default value). It is assumed that there are no exposure pathways that link contaminants below 3 m (10 ft) to humans, animals, or plants; therefore, the groundwater protection PRG (1292 pCi/g) is applied at the > 3 m (10 ft) depth strata. The groundwater protection PRG is also applied to the 0 to 3 m (0 to 10 ft) depth strata if it is more stringent than the human-risk PRG.

To identify the refined COPCs at each waste site, the following assumptions and protocols are used to compare COPCs to PRGs:

- Waste site soils are divided into two zones (0 to 3 m [10 ft] and > 3 m [10 ft]) that correspond to the intervals that human and biological receptors and groundwater could be exposed to. This approach is discussed in detail in Section 2.0 and Appendix A of the Process Document.

- At each waste site, the maximum concentration of each COPC within each interval is identified using the 1993 LFI data (DOE-RL 1994a) and Dorian and Richards' 1975 field data set (Dorian and Richards 1978).

- The historical data set (Dorian and Richards 1978) is modified to account for radioactive decay between 1975 and 1992, so it is consistent with the PRGs established in 1992. The LFI data collected in 1993 are also modified to account for decay from 1992 to 1993.

- If a sample is collected at the boundary between two intervals (i.e., at 1 m [3 ft]), the data from that sample are applied to both intervals.

- Historical or LFI data reported within a range (e.g., 2.6 to 4.8 m [8.5 to 16 ft]) are applied to two depth intervals if appropriate (e.g., the 0 to 3 m [0 to 10 ft] and the greater than 3 m [10 ft] ranges).

- The nickel-63 concentrations reported by Dorian and Richards (1978) may have been analyzed using a surrogate. Therefore, the concentrations reported in this FFS may not be an accurate representation of the actual concentration at the waste site. For the purpose of this FFS, the nickel-63 concentrations reported by Dorian and Richards (1978) are used as the best available estimate.

- Total uranium concentrations were reported by Dorian and Richards (1978) rather than specific isotopes. For the purpose of this FFS, the total concentrations are considered to be uranium-238 because uranium-238 was determined to be the major risk contributor of the uranium isotopes during the QRA.

The screening process that compares the COPCs to PRGs, and identifies the refined COPCs, results in the identification of the contaminants that must be addressed by remedial action at a given IRM candidate site. Tables M2-4 through M2-7 present the PRG screening for the candidate sites at the 100-KR-1 Operable Unit, and Table M2-8 includes the refined COPCs for each waste site.

2.4.3 Waste-site Profiles

The waste-site profiles characterizing each waste site are presented in Table M2-8. Each profile includes the following:

- Extent of contamination
- Media (i.e., soil) or material at the waste site
- List of the refined COPCs
- Maximum concentration observed for each refined COPC at the waste site.

The waste-site profiles also include whether contaminant concentrations exceed the reduced infiltration concentration. The reduced infiltration concentration is the soil concentration that is considered protective of groundwater under the assumption that hydraulic infiltration is limited by a surface barrier over the wastes. The reduced infiltration concentrations are presented in Table M2-9; their derivation is discussed in Appendix A of the Process Document.

Waste-site profiles serve several purposes. Profiles contain information needed to compare each waste site at 100-KR-1 to the waste-site groups developed in Section 3.0 of the Process Document. The profile information is also used to compare the site characteristics of each waste site with the applicability criteria developed in Section 4.0 of the Process Document, to help determine which remedial alternatives are or are not preferred for that site. Area, depth, and volume of contamination are used to determine how much soil may have to be excavated, treated, or capped. This determination has a direct bearing on the time and costs for remedial action. Information found in the profiles is explained more in the following paragraphs and the actual profiles are presented in Table M2-8.

- **Extent of Contamination** - This includes the volume, length, width, area, and thickness of the contaminated media. The volume estimates performed for each site are presented in Attachment 1 of this FFS. Volume, length, width, and area do not necessarily impact the determination of preferred remedial alternatives. However, they are important considerations for determining costs and estimating the time required for remedial actions. Thickness of the contaminated lens impacts the implementability of in situ actions such as vitrification, which has a limited vertical extent of influence.

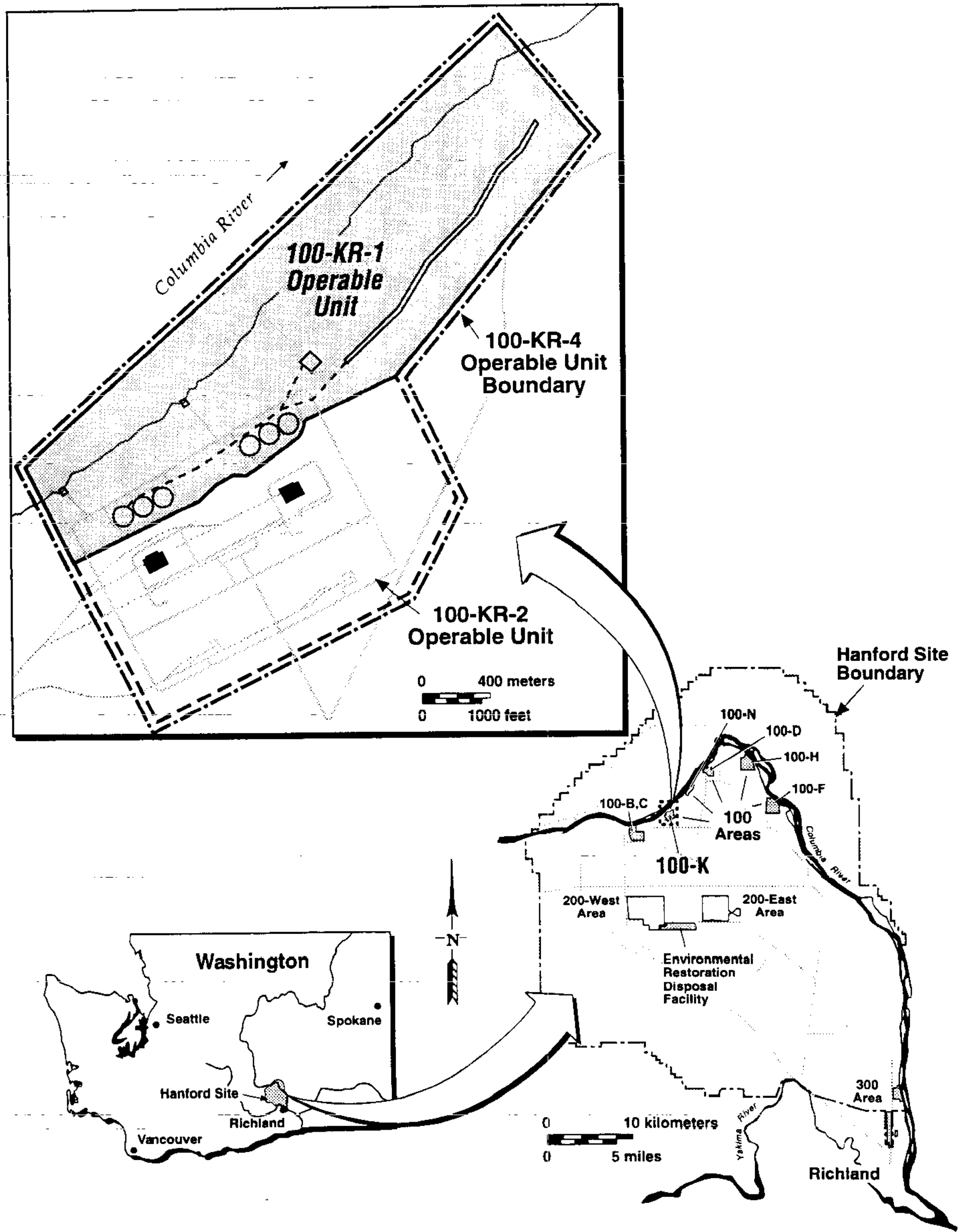
- **Contaminated Media/Material** - Contaminated media and material located at the site are determined and described. Structural materials such as steel, concrete, and wooden timbers influence the applicability of remedial alternatives, selection of removal equipment, and material handling considerations. The presence of structural materials influences material handling considerations and may require remedial alternatives that are different than alternatives for sites with just contaminated soil.

- **Refined COPC/Maximum Concentrations** - Refined COPCs for a site are determined as discussed in Section 2.4.2. The associated maximum concentration for each refined COPC is the highest concentration detected in samples from the site. Refined COPCs may influence the applicability of remedial alternatives. For example, the presence of radioactive contaminants with short half-lives may allow consideration of natural decay in determining preferred remedial actions. The presence of organic contaminants may require that enhancements (such as thermal desorption) be added to a treatment system.

- **Reduced Infiltration Concentration** - Reduced infiltration concentration (Table M2-9) is used to consider protection of groundwater under a scenario where hydraulic infiltration is limited by the application of a surface barrier. It is a calculated value that is compared with the maximum refined COPC concentration detected at the waste site. Exceedance of one or more of the reduced infiltration concentrations indicates that containment alternatives using a surface cap may not prevent contaminants from leaching into the groundwater below the site. Thus, the containment alternative would not be appropriate for the site.

Section 3.0 describes the use of site profiles in application of the plug-in approach during the feasibility study process.

Figure M2-1. Location of the Hanford Site and the 100-K Area.



E9506047.1

Figure M2-2. Location of Waste Sites within the 100-KR-1 Operable Unit.

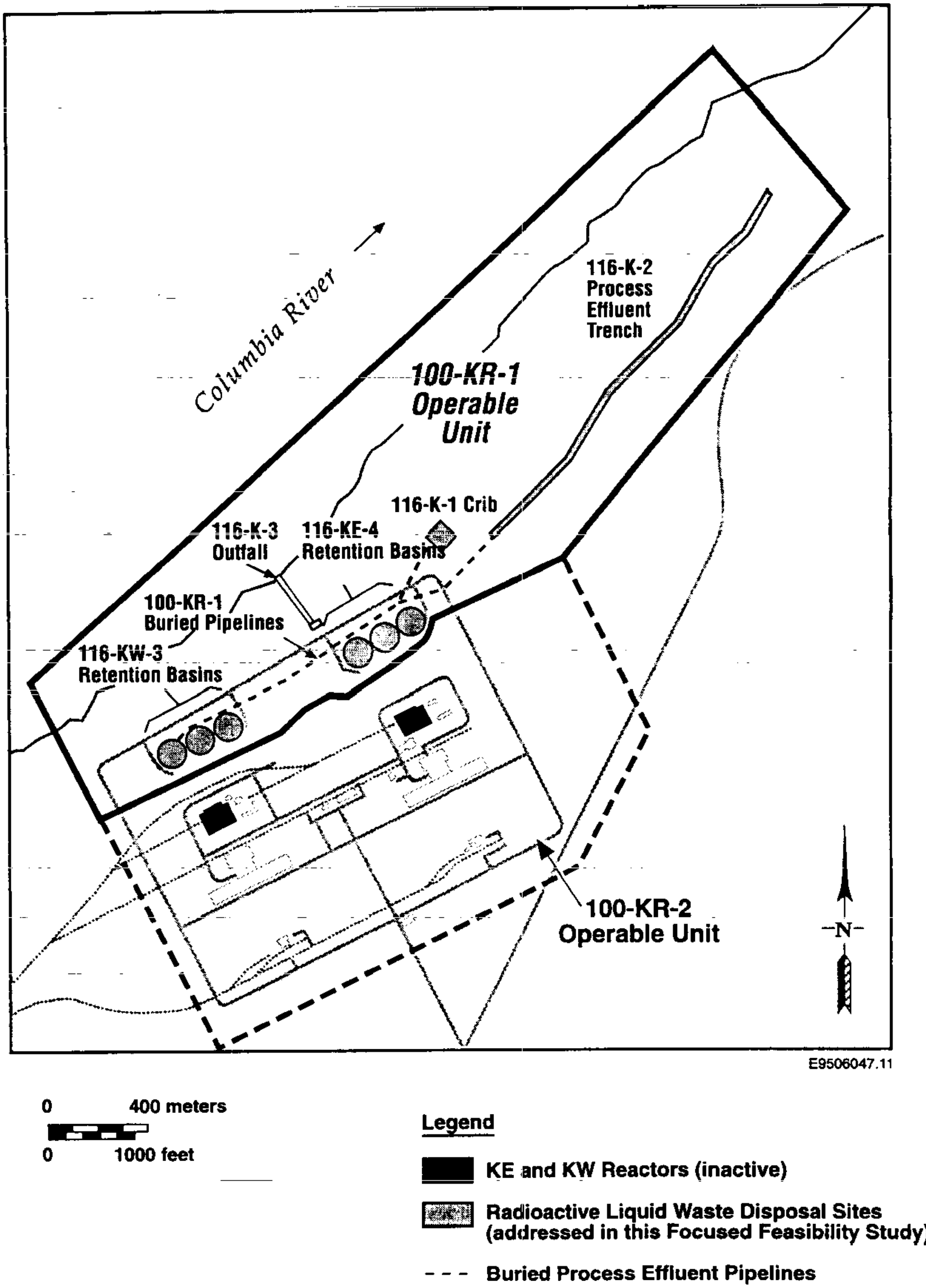


Table M2-1. Interim Remedial Measures Recommendations for 100-KR-1 High-Priority Sites.

Waste Site	Qualitative Risk Assessment		Conceptual Model	Exceeds ARARs	Probable Current Groundwater Impact	Natural Attenuation by 2018	IRM Candidate
	Occasional-Use Scenario	EHQ >1					
116-K-1 Crib	Medium	No	Adequate	No	No	No	Yes
116-K-2 Process Effluent Trench	Medium	Yes	Adequate	No	No	No	Yes
116-KW-3 Retention Basins	Medium	Yes	Adequate	Yes	No	No	Yes
116-KE-4 Retention Basins	High	No	Adequate	No	No	No	Yes
116-K-3 Outfall Structure	Medium	Not evaluated	Adequate	Unknown	No	Unknown	Yes
100-KR-1 Buried Process Effluent Pipelines	Medium	Not evaluated	Adequate	Unknown	Unknown	Yes[a]	Yes

Source: *Limited Field Investigation for the 100-KR-1 Operable Unit* (DOE-RL 1994a).

[a]Based on further analysis of the data presented in the LFI, some radionuclides will be above the PRGs beyond 2018.

Table M2-2. Description of Interim Remedial Measures Candidate Waste Sites at the 100-KR-1 Operable Unit.

Waste-Site Group[a]	Site Number/ Name	Site Use During Reactor Operation	Physical Description[b]	Data Source
Process Effluent Trench	116-K-1 Crib	Received 40 million liters of radioactive reactor cooling effluent wastes contaminated by fuel cladding ruptures.	Crib area is 61 x 61 m. Crib surrounded by earthen embankment extending 6.1 m above crib bottom. Outer edge of embankment encompasses area 122 x 122 m.	Limited Field Investigation, Historical[c]
Process Effluent Trench	116-K-2 Process Effluent Trench	Received 300 billion liters of contaminated effluent that included radioactive reactor cooling effluent and contaminated water from floor drains in 105-KE and 105-KW Reactors. Also buried in trench is a construction tractor and all "hydride" tanks from the 100-K Area.	Open trench is 1249.7 m long, 13.7 m wide, and 7.6 m deep. Trench was excavated 5.3 m below grade and surrounded by a berm 2.3 m high. About 6.6 m of fill placed in trench in 1971, except at inlet end of trench. First 290 m of trench, the inlet end, now contains about 6.8 m of fill.	Limited Field Investigation, Historical[c]
Retention Basins	116-KW-3 Retention Basins	Held cooling water effluent from 105-KW Reactor for cooling/decay before release to the Columbia River.	Three open-topped welded carbon steel tanks 76.2 m dia. x 8.8 m high.	Limited Field Investigation, Historical[c]
Retention Basins	116-KE-4 Retention Basins	Held cooling water effluent from 105-KE Reactor for cooling/decay before release to the Columbia River.	Three open-topped welded carbon steel tanks 76.2 m dia. x 7.62 m high. About 3/4 of the tank walls have been removed.	Limited Field Investigation, Historical[c]
Pipelines	100-KR-1 Buried Process Effluent Pipelines	Transported reactor cooling water to retention basins, 116-K-3 Outfall Structure, 116-K-1 Crib, and 116-K-2 Process Effluent Trench. Contains contaminated sludge and scale.	Lines are 183 cm, 168 cm, 152 cm, 107 cm, 91 cm, and 30 cm in diameter; buried 1.9 to 5.2 m below grade. About 3/4 of the tank walls have been removed.	Analogous[d]

NOTE: Dimensions are bottom dimensions of the waste sites.
[a]Waste-Site groups are defined and described in the Process Document.
[b]Physical dimensions do not reflect extent of contamination.
[c]Dorian and Richards (1978).
[d]Data from analogous site; the buried process effluent pipelines at 100-BC-1 (DOE-RL 1994a).

Table M2-3. Preliminary Remediation Goals for Source Operable Units.

	HUMAN-HSRAM (a)		PROTECTION of GROUNDWATER (b)	BACKGROUND (c,d)	CRQL/CRDL (e) or as noted		ZONE SPECIFIC PRG	
	TR = 1E-06	HQ = 0.1					1 (f) 0-10 ft.	2 (g) >10 ft.
RADIONUCLIDES (pCi/g)								
Am-241	76.9	N/A	31	N/C	1		31	31
C-14	44,200	N/A	18	N/C	50		50	50
Cs-134	3,460	N/A	517	N/C	0.1		517	517
Cs-137	5.68	N/A	775	1.8	0.1		6	775
Co-60	17.5	N/A	1,292	N/C	0.05		18	1,292
Eu-152	5.96	N/A	20,667	N/C	0.1		6	20,667
Eu-154	10.6	N/A	20,667	N/C	0.1		11	20,667
Eu-155	3,080	N/A	103,000	N/C	0.1		3,080	103,000
H-3	2,900,000	N/A	517	N/C	400		517	517
K-40	12.1	N/A	145	19.7	4		19.7	145
Na-22	545	N/A	207	N/C	4	(h)	207	207
Ni-63	184,000	N/A	46,500	N/C	30		46,500	46,500
Pu-238	87.9	N/A	5	N/C	1		5	5
Pu-239/240	72.8	N/A	4	0.035	1		4	4
Ra-226	1.1	N/A	0.03	0.98	0.1		1	1
Sr-90	1,930	N/A	129	0.36	1		129	129
Tc-99	28,900	N/A	26	N/C	15		26	26
Th-228	7,260	N/A	0.1	N/C	1	(i)	1	1
Th-232	162	N/A	0.01	N/C	1		1	1
U-233/234	165	N/A	5	1.1	1		5	5
U-235	23.6	N/A	6	N/C	1		6	6
U-238 (j)	58.4	N/A	6	1.04	1		6	6
INORGANICS (mg/kg)								
Antimony	N/A	167	0.002	N/C	6		6	6
Arsenic	16.2	125	0.013	9	1		9	9
Barium	N/A	29,200	258	175	20		258	258
Cadmium	1,360	417	0.775	N/C	0.5		0.8	0.775
Chromium VI	204	2,086	0.026	28	1		28	28
Lead	N/C	N/C	8	14.9	0.3		14.9	14.9
Manganese	N/A	2,086	13	583	1.5		583	583
Mercury	N/A	125	0.31	1.3	0.02		1.3	1.3
Zinc (k)	N/A	100,000	775	79	2		775	775
ORGANICS (mg/kg)								
Aroclor 1260 (PCB)	4.34	N/A	1.37	<0.033	0.033		1	1
Benzo(a)pyrene	5	N/A	5.68	<0.330	0.330		5	6
Chrysene	N/A	N/A	0.01	<0.330	0.330		0.330	0.330
Pentachlorophenol	300	N/A	0.27	<0.8	0.8		0.8	0.8

TR=Target Risk, HQ= Hazard Quotient; N/A=Not Applicable; N/C=Not calculated
(a) Occasional Use Scenario.
(b) Based on Summer's Model (EPA 1989b).
(c) Status Report, Hanford Site Background: Evaluation of Existing Soil Radionuclide Data (Letter #008106).
(d) Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes, DOE/RL-92-24, Rev. 2.
(e) Based on 100-BC-5 OU Work Plan QAPP (DOE-RL 1992).
(f) PRGs are established to be protective of groundwater, human and ecological receptors.
(g) PRGs are established to be protective of groundwater.
(h) Based on gross beta analysis.
(i) Detection limit assumed to be same as Th-232.
(j) Includes total U if no other data exist.
(k) Value calculated exceeds 1,000,000 ppm therefore use 100,000 ppm as default.

Table M2-4. 116-K-1 Crib Refined Contaminants of Potential Concern.

116-K-1	Zone 1 (a)						Zone 2 (b)										Refined COPC Summary
	0 - 3 ft		3 - 6 ft		6 - 10 ft		10 - 15 ft		15 - 20 ft		20 - 25 ft		25 - 30 ft		30 - 35 ft		
	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	
RADIONUCLIDES (pCi/g)																	
Am-241		NO	1 7E+00	NO		NO	4.7E-02	NO		NO		NO		NO		NO	
C-14		NO		NO		NO		NO		NO		NO		NO		NO	
Cs-134	2 1E-02	NO	1.3E-02	NO		NO	1 5E-04	NO	1 5E-04	NO	1.1E-04	NO	1.1E-04	NO		NO	
Cs-137	**5.2E+02**	**YES**	**3.0E+02**	**YES**	4.5E-01	NO	3 5E+00	NO	3 1E-02	NO	3 5E-02	NO	3.5E-02	NO		NO	**YES**
Co-60	**3.3E+01**	**YES**	1 6E+01	NO	3 8E-02	NO	5 8E-01	NO	6.8E-02	NO		NO	5 8E-03	NO		NO	**YES**
Eu-152	**1.8E+02**	**YES**	**7.6E+01**	**YES**	1.3E-01	NO	4 3E+00	NO	4.1E-01	NO		NO		NO		NO	**YES**
Eu-154	**4.5E+01**	**YES**	**1.4E+01**	**YES**		NO	7 4E-01	NO	1.7E-01	NO		NO		NO		NO	**YES**
Eu-155	1.3E+00	NO	4 1E-01	NO	1 4E-02	NO	1 6E-02	NO	1.7E-02	NO		NO		NO		NO	
H-3		NO		NO		NO		NO		NO		NO		NO		NO	
K-40	1 0E+01	NO	1 7E+01	NO		NO	1 3E+01	NO	9 6E+00	NO	1 3E+01	NO	1.3E+01	NO		NO	
Na-22		NO		NO		NO		NO		NO		NO		NO		NO	
Ni-63		NO		NO		NO		NO		NO		NO		NO		NO	
Pu-238	4.2E-01	NO	1 9E-01	NO		NO		NO		NO		NO		NO		NO	
Pu-239/240	**4.4E+00**	**YES**	2.4E+00	NO		NO	7.0E-02	NO		NO	3 2E-03	NO		NO		NO	**YES**
Ra-226	4.7E-01	NO	5.7E-01	NO		NO	4 2E-01	NO		NO	4 4E-01	NO	4.4E-01	NO		NO	
Sr-90	6 6E+00	NO	4.2E+00	NO	4 8E+00	NO	5.4E+00	NO	5.2E+00	NO	6 6E-01	NO	1.7E-02	NO		NO	
Tc-99		NO		NO		NO		NO		NO		NO		NO		NO	
Th-228	6 6E-01	NO	8.0E-01	NO		NO	6.4E-01	NO	6.0E-01	NO	6.5E-01	NO	6.5E-01	NO		NO	
Th-232	7 7E-01	NO	7.4E-01	NO		NO	4 6E-01	NO		NO	7.4E-01	NO	7.4E-01	NO		NO	
U-233/234	4 9E-01	NO	6 1E-01	NO		NO	3 5E-01	NO	2.9E-01	NO	3 8E-01	NO	3.8E-01	NO		NO	
U-235		NO		NO		NO		NO		NO		NO		NO		NO	
U-238	6 4E-01	NO	5.7E-01	NO		NO	5.4E-01	NO	2.0E-01	NO	4.4E-01	NO	4 4E-01	NO		NO	
INORGANICS (mg/kg)																	
Antimony		NO		NO		NO		NO		NO		NO		NO		NO	
Arsenic		NO	2.7E+00	NO		NO		NO		NO		NO		NO		NO	
Barium	5.78E+01	NO	6.04E+01	NO	5 96E+01	NO	4 60E+01	NO	5 01E+01	NO	5 01E+01	NO		NO		NO	
Cadmium		NO		NO		NO		NO		NO		NO		NO		NO	
Chromium VI	5 1E+00	NO		NO		NO		NO		NO		NO		NO		NO	
Lead	4 6E+00	NO	4.4E+00	NO	3 6E+00	NO	2.8E+00	NO	3.2E+00	NO	3 2E+00	NO		NO		NO	
Manganese	2 98E+02	NO	2 81E+02	NO	2 38E+02	NO	1.85E+02	NO	1.85E+02	NO	1.70E+02	NO		NO		NO	
Mercury		NO	3.1E-01	NO		NO		NO		NO		NO		NO		NO	
Zinc	3 51E+01	NO	4.38E+01	NO	2 85E+01	NO	2 43E+01	NO	2 43E+01	NO	2 41E+01	NO		NO		NO	
ORGANICS (mg/kg)																	
Aroclor 1260 (PCB)		NO		NO		NO		NO		NO		NO		NO		NO	
Benzo(a)pyrene		NO		NO		NO		NO		NO		NO		NO		NO	
Chrysene		NO		NO		NO		NO		NO		NO		NO		NO	
Pentachlorophenol		NO		NO		NO		NO		NO		NO		NO		NO	

* Maximum concentrations are screened against PRGs. "Yes" if the value exceeds PRGs, "No" if the value is below PRGs.
COPCs are refined based on the soil concentration and PRGs
A blank under "Max" means either no information is available, or the constituent was not detected

116K1 XLS

(a) PRGs are established to be protective of groundwater, human, and ecological receptors
(b) PRGs are established to be protective of groundwater.
Sources:
Dorian and Richards 1978 Table 2 7-36
DOE-RL 1994g Table 3-3

Table M2-5. 116-K-2 Process Effluent Trench Refined Contaminants of Potential Concern.

	Zone 1 (a)						Zone 2 (b)										Refined
116-K-2	0 - 3 ft		3 - 6 ft		6 - 10 ft		10 - 15 ft		15 - 20 ft		20 - 25 ft		25 - 30 ft		30 - 35 ft		COPC
	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Summary
RADIONUCLIDES (pCi/g)																	
Am-241		NO		NO		NO		NO	1 3E+01	NO	8 0E-02	NO		NO		NO	
C-14		NO		NO		NO	3 2E+01	NO	1.1E+01	NO		NO		NO		NO	
Cs-134	1 8E-02	NO	2 5E-04	NO		NO	1 7E+00	NO	1.7E+00	NO	4.9E-02	NO	3.0E-02	NO		NO	
Cs-137	**8.1E+01**	**YES**	1 9E+00	NO	4.0E-01	NO	6.2E+02	NO	**1.9E+03**	**YES**	**2.0E+03**	**YES**	4.2E+02	NO	1 8E+00	NO	**YES**
Co-60	**2.9E+01**	**YES**	4 9E-01	NO	1.6E-01	NO	1.4E+02	NO	3 7E+02	NO	2.4E+02	NO	2 9E+01	NO	4 7E+00	NO	**YES**
Eu-152	**2.5E+02**	**YES**	2.8E+00	NO	1 4E+00	NO	1.8E+04	NO	1.8E+04	NO	1 6E+03	NO	5 0E+02	NO	2.6E+00	NO	**YES**
Eu-154	**6.6E+01**	**YES**	7 3E-01	NO	2.9E-01	NO	4.5E+03	NO	4.5E+03	NO	3.7E+02	NO	1.2E+02	NO	5 0E-02	NO	**YES**
Eu-155	6 0E+00	NO	3 5E-02	NO	3 1E-02	NO	8.8E+01	NO	8.8E+01	NO	1 3E+01	NO	5 3E+00	NO	5 4E-03	NO	
H-3	1.0E+02	NO	1 1E+00	NO	2.2E-01	NO	3 1E+01	NO	5.0E+01	NO	3.5E+01	NO		NO		NO	
K-40	1.2E+01	NO		NO		NO		NO		NO	1.4E+01	NO	1.3E+01	NO		NO	
Na-22		NO		NO		NO		NO		NO		NO		NO		NO	
Ni-63		NO		NO		NO	4 5E+03	NO		NO		NO		NO		NO	
Pu-238	1 7E-01	NO	2 7E-01	NO		NO	3.5E+00	NO	3.5E+00	NO	5 6E-01	NO	2 6E-01	NO		NO	
Pu-239/240	2 5E+00	NO	**7.6E+00**	**YES**		NO	**1.3E+02**	**YES**	**1.3E+02**	**YES**	**1.3E+01**	**YES**	**4.9E+00**	**YES**	1.9E-01	NO	**YES**
Ra-226	4 9E-01	NO		NO		NO		NO		NO	4 8E-01	NO	5 0E-01	NO		NO	
Sr-90	4 1E+00	NO	1 7E+01	NO	1 8E-01	NO	**1.5E+02**	**YES**	**1.5E+02**	**YES**	2 5E+01	NO	2 5E+01	NO	1 3E+00	NO	**YES**
Tc-99		NO		NO		NO		NO		NO		NO		NO		NO	
Th-228	**1.1E+00**	**YES**		NO		NO		NO		NO	8 2E-01	NO	8 5E-01	NO		NO	**YES**
Th-232	7 1E-01	NO		NO		NO		NO		NO	8 2E-01	NO	5 8E-01	NO		NO	
U-233/234	5.4E-01	NO		NO		NO		NO	8.1E-01	NO	6.1E-01	NO	4 8E-01	NO		NO	
U-235		NO		NO		NO		NO		NO		NO		NO		NO	
U-238	3 6E-01	NO	3 6E-01	NO	2 4E+00	NO	2 1E+00	NO	2.1E+00	NO	4.5E-01	NO	5 6E-01	NO		NO	
INORGANICS (mg/kg)																	
Antimony		NO		NO		NO		NO		NO		NO		NO		NO	
Arsenic	2 5E+00	NO		NO		NO		NO	2 1E+00	NO	1 5E+00	NO	1 4E+00	NO		NO	
Barium	6 30E+01	NO		NO		NO		NO	5 82E+01	NO	7 47E+01	NO	1 22E+02	NO		NO	
Cadmium		NO		NO		NO		NO		NO		NO		NO		NO	
Chromium VI	1 12E+01	NO		NO		NO		NO	**1.53E+02**	**YES**	2.17E+01	NO	1 72E+01	NO		NO	**YES**
Lead		NO		NO		NO		NO		NO		NO		NO		NO	
Manganese	3 09E+02	NO		NO		NO		NO	2 29E+02	NO	2.97E+02	NO	2 84E+02	NO		NO	
Mercury		NO		NO		NO		NO	**3.90E+00**	**YES**		NO	1 30E-01	NO		NO	**YES**
Zinc	4 45E+01	NO		NO		NO		NO	1 43E+02	NO		NO	3 90E+01	NO		NO	
ORGANICS (mg/kg)																	
Aroclor 1260 (PCB)		NO		NO		NO		NO		NO		NO		NO		NO	
Benzo(a)pyrene		NO		NO		NO		NO		NO		NO		NO		NO	
Chrysene		NO		NO		NO		NO		NO		NO		NO		NO	
Pentachlorophenol		NO		NO		NO		NO		NO		NO		NO		NO	

* Maximum concentrations are screened against PRGs "Yes" if the value exceeds PRGs; "No" if the value is below PRGs
COPCs are refined based on the soil concentration and PRGs
A blank under "Max" means either no information is available, or the constituent was not detected

(a) PRGs are established to be protective of groundwater, human, and ecological receptors
(b) PRGs are established to be protective of groundwater
Sources
Dorian and Richards 1978 Tables 2 7-37 and 2 7-38
DOE-RL 1994g Table 3-4

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Table M2-6. 116-KW-3 Retention Basins Refined Contaminants of Potential Concern.

	Zone 1 (a)						Zone 2 (b)										Refined
116-KW-3	0 - 3 ft		3 - 6 ft		6 - 10 ft		10 - 15 ft		15 - 20 ft		20 - 25 ft		25 - 30 ft		30 - 35 ft		COPC
	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Summary
RADIONUCLIDES (pCi/g)																	
Am-241		NO		NO		NO		NO		NO		NO		NO		NO	
C-14		NO		NO		NO		NO	8.1E-01	NO	8.1E-01	NO		NO		NO	
Cs-134	2.7E-02	NO		NO	1.4E-04	NO	1.5E-04	NO	1.4E-04	NO	1.4E-04	NO		NO		NO	
Cs-137	**1.6E+02**	**YES**		NO	5.1E-01	NO	2.9E+00	NO	6.4E-01	NO	2.9E-02	NO	2.9E-02	NO		NO	**YES**
Co-60	**1.4E+02**	**YES**		NO	1.1E-01	NO	1.1E-01	NO	2.2E-02	NO	4.7E-03	NO		NO		NO	**YES**
Eu-152	**4.6E+02**	**YES**		NO	9.2E-01	NO	9.2E-01	NO	4.0E-01	NO	2.0E-01	NO		NO		NO	**YES**
Eu-154	**1.7E+02**	**YES**		NO	1.8E-01	NO	1.3E-01	NO	5.5E-02	NO		NO		NO		NO	**YES**
Eu-155	5.3E+01	NO		NO	2.7E-02	NO	2.7E-02	NO	1.6E-02	NO	9.3E-03	NO		NO		NO	
H-3	3.0E+00	NO		NO		NO	1.2E+01	NO	1.2E+01	NO		NO		NO		NO	
K-40	1.2E+01	NO		NO	1.4E+01	NO	1.5E+01	NO	1.6E+01	NO	1.6E+01	NO		NO		NO	
Na-22		NO		NO		NO		NO		NO		NO		NO		NO	
Ni-63	7.8E+02	NO		NO		NO		NO		NO		NO		NO		NO	
Pu-238		NO		NO		NO		NO		NO		NO		NO		NO	
Pu-239/240	**8.3E+00**	**YES**		NO		NO		NO		NO		NO		NO		NO	**YES**
Ra-226	6.0E-01	NO		NO	6.8E-01	NO	8.6E-01	NO	8.6E-01	NO	8.5E-01	NO		NO		NO	
Sr-90	5.2E+01	NO		NO	1.2E-01	NO	7.3E-01	NO	7.3E-01	NO	1.7E-01	NO	1.7E-01	NO		NO	
Tc-99		NO		NO		NO		NO		NO		NO		NO		NO	
Th-228	9.7E-01	NO		NO	**1.3E+00**	**YES**	**1.3E+00**	**YES**	**1.7E+00**	**YES**	**1.7E+00**	**YES**		NO		NO	**YES**
Th-232	7.1E-01	NO		NO	9.6E-01	NO	**1.1E+00**	**YES**	**1.4E+00**	**YES**	**1.4E+00**	**YES**		NO		NO	**YES**
U-233/234	**1.7E+01**	**YES**		NO	7.0E-01	NO	7.4E-01	NO	1.0E+00	NO	1.0E+00	NO		NO		NO	**YES**
U-235	1.7E+00	NO		NO		NO		NO		NO		NO		NO		NO	
U-238	**1.7E+01**	**YES**		NO	6.1E-01	NO	9.1E-01	NO	9.1E-01	NO	7.3E-01	NO		NO		NO	**YES**
INORGANICS (mg/kg)																	
Antimony	3.9E+00	NO		NO		NO		NO	3.3E+00	NO	3.3E+00	NO		NO		NO	
Arsenic	3.2E+00	NO		NO	3.5E+00	NO	3.5E+00	NO	4.1E+00	NO	4.1E+00	NO		NO		NO	
Barium	7.07E+01	NO		NO	9.04E+01	NO	9.04E+01	NO	7.58E+01	NO	6.54E+01	NO		NO		NO	
Cadmium		NO		NO		NO		NO		NO		NO		NO		NO	
Chromium VI	1.78E+01	NO		NO	1.48E+01	NO	1.68E+01	NO	1.72E+01	NO	1.72E+01	NO		NO		NO	
Lead	1.48E+01	NO		NO	6.50E+00	NO	6.50E+00	NO	7.60E+00	NO	7.60E+00	NO		NO		NO	
Manganese	3.59E+02	NO		NO	3.68E+02	NO	3.68E+02	NO	2.92E+02	NO	2.62E+02	NO		NO		NO	
Mercury	2E-01	NO		NO	6E-02	NO	6E-02	NO	6E-02	NO		NO		NO		NO	
Zinc	5.94E+01	NO		NO	5.24E+01	NO	5.24E+01	NO	3.97E+01	NO	3.97E+01	NO		NO		NO	
ORGANICS (mg/kg)																	
Aroclor 1260 (PCB)		NO		NO		NO		NO		NO		NO		NO		NO	
Benzo(a)pyrene	1.30E-01	NO		NO		NO		NO		NO		NO		NO		NO	
Chrysene	3.10E-01	NO		NO		NO		NO		NO		NO		NO		NO	
Pentachlorophenol	3.90E-01	NO		NO		NO		NO		NO		NO		NO		NO	

* Maximum concentrations are screened against PRGs "Yes" if the value exceeds PRGs, "No" if the value is below PRGs
COPCs are refined based on the soil concentration and PRGs
A blank under "Max" means either no information is available, or the constituent was not detected

(a) PRGs are established to be protective of groundwater, human, and ecological receptors
(b) PRGs are established to be protective of groundwater
Sources
Dorian and Richards 1978 Tables 2.7-27 and 2.7-29
DOE-RL 1994g Tables 3-8, 3-9, and 3-10
WHC-SD-EN-TI-150, Rev 0, or WHC-SD-EN-TI-151, Rev 0

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Table M2-7. 116-KE-4 Retention Basins Refined Contaminants of Potential Concern.

116-KE-4	Zone 1 (a) 0 - 3 ft Max	Zone 1 (a) 0 - 3 ft Screening*	3 - 6 ft Max	3 - 6 ft Screening*	6 - 10 ft Max	6 - 10 ft Screening*	Zone 2 (b) 10 - 15 ft Max	10 - 15 ft Screening*	15 - 20 ft Max	15 - 20 ft Screening*	20 - 25 ft Max	20 - 25 ft Screening*	25 - 30 ft Max	25 - 30 ft Screening*	30 - 35 ft Max	30 - 35 ft Screening*	Refined COPC Summary
RADIONUCLIDES (pCi/g)																	
Am-241		NO		NO		NO		NO		NO		NO		NO		NO	
C-14		NO		NO		NO		NO		NO		NO		NO		NO	
Cs-134	5.9E-01	NO	6.6E-04	NO		NO		NO	3.3E-04	NO	5.6E-02	NO		NO		NO	
Cs-137	**5.3E+03**	**YES**	1.6E+00	NO		NO	1.0E-01	NO	1.6E+01	NO	1.6E+01	NO		NO		NO	YES
Co-60	**8.2E+02**	**YES**	2.1E+00	NO		NO	2.5E-02	NO	7.1E-02	NO	7.1E-02	NO		NO		NO	YES
Eu-152	**2.1E+04**	**YES**	**2.8E+01**	**YES**	7.1E-02	NO	2.4E-01	NO	5.5E-01	NO	5.5E-01	NO		NO		NO	YES
Eu-154	**4.5E+03**	**YES**	6.3E+00	NO		NO	5.2E-02	NO	2.9E-01	NO	2.9E-01	NO		NO		NO	YES
Eu-155	2.5E+01	NO	4.9E-01	NO		NO	9.3E-02	NO	9.3E-02	NO	7.0E-02	NO		NO		NO	
H-3	4.2E+01	NO	8.0E-01	NO		NO		NO		NO		NO		NO		NO	
K-40	1.5E+01	NO		NO	1.3E+01	NO	1.3E+01	NO	1.4E+01	NO	1.6E+01	NO		NO		NO	
Na-22		NO		NO		NO		NO		NO		NO		NO		NO	
Ni-63	5.4E+02	NO		NO		NO		NO		NO		NO		NO		NO	
Pu-238	8.2E-01	NO		NO		NO		NO		NO		NO		NO		NO	
Pu-239/240	**1.2E+01**	**YES**	1.9E-01	NO		NO		NO		NO		NO		NO		NO	YES
Ra-226	7.7E-01	NO		NO	5.3E-01	NO	5.3E-01	NO	4.4E-01	NO	5.0E-01	NO		NO		NO	
Sr-90	8.6E+00	NO	4.0E+00	NO		NO	8.1E-01	NO	8.1E-01	NO	7.3E-01	NO		NO		NO	
Tc-99		NO		NO		NO		NO		NO		NO		NO		NO	
Th-228	**1.2E+00**	**YES**		NO	9.2E-01	NO	9.2E-01	NO	8.1E-01	NO	6.6E-01	NO		NO		NO	YES
Th-232	**1.1E+00**	**YES**		NO	7.3E-01	NO	7.3E-01	NO	7.8E-01	NO	7.7E-01	NO		NO		NO	YES
U-233/234	6.6E-01	NO		NO	4.5E-01	NO	4.7E-01	NO	4.6E-01	NO	4.6E-01	NO		NO		NO	
U-235		NO		NO		NO		NO		NO		NO		NO		NO	
U-238	1.6E+00	NO		NO	4.2E-01	NO	5.1E-01	NO	5.1E-01	NO	4.1E-01	NO		NO		NO	
INORGANICS (mg/kg)																	
Antimony	4.0E+00	NO		NO		NO		NO	3.2E+00	NO		NO		NO		NO	
Arsenic	2.2E+00	NO		NO	8.4E-01	NO	8.4E-01	NO		NO		NO		NO		NO	
Barium	6.87E+01	NO		NO	5.60E+01	NO	5.60E+01	NO	6.58E+01	NO	6.04E+01	NO		NO		NO	
Cadmium		NO		NO		NO		NO		NO		NO		NO		NO	
Chromium VI	**8.51E+01**	**YES**		NO	2.10E+01	NO	2.10E+01	NO	1.24E+01	NO	1.11E+01	NO		NO		NO	YES
Lead	7.2E+00	NO		NO	5.4E+00	NO	5.4E+00	NO	3.6E+00	NO	3.5E+00	NO		NO		NO	
Manganese	4.17E+02	NO		NO	1.68E+02	NO	1.68E+02	NO	2.66E+02	NO	2.13E+02	NO		NO		NO	
Mercury	7.0E-02	NO		NO		NO	3.70E-01	NO	4.2E-01	NO	4.2E-01	NO		NO		NO	
Zinc	5.08E+01	NO		NO	2.92E+01	NO	2.92E+01	NO	3.52E+01	NO	2.81E+01	NO		NO		NO	
ORGANICS (mg/kg)																	
Aroclor 1260 (PCB)		NO		NO		NO		NO		NO		NO		NO		NO	
Benzo(a)pyrene		NO		NO		NO		NO		NO		NO		NO		NO	
Chrysene		NO		NO		NO		NO		NO		NO		NO		NO	
Pentachlorophenol		NO		NO		NO		NO		NO		NO		NO		NO	

* Maximum concentrations are screened against PRGs. "Yes" if the value exceeds PRGs; "No" if the value is below PRGs.
COPCs are refined based on the soil concentration and PRGs
A blank under "Max" means either no information is available, or the constituent was not detected

(a) PRGs are established to be protective of groundwater, human, and ecological receptors
(b) PRGs are established to be protective of groundwater
Sources:
Dorian and Richards 1978 Tables 2.7-26 and 2.7-28
DOE-RL 1994g Tables 3-8, 3-9, and 3-10
WHC-SD-EN-TI-150, Rev. 0, or WHC-SD-EN-TI-151, Rev. 0

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Table M2-8. 100-KR-1 Operable Unit Waste-Site Profiles.
(Page 1 of 2 sheets)

Waste Site (Group)	Extent of Contamination					Media/ Material	Refined COPCs	Maximum Concentration Detected (a)	Are Reduced Infiltration Concentrations Exceeded?
	Volume (m^3)	Length (m)	Width (m)	Area (m^2)	Thickness (m)				
116-K-1 (Process Effluent Trench)	6800.0	61.0	61.0	3716.0	1.8	Soil	Radionuclides	pCi/g	
							^{60}Co	$3.3x10^1$	NO
							^{137}Cs	$5.2x10^2$	NO
							^{152}Eu	$1.8x10^2$	NO
							^{154}Eu	$4.5x10^1$	NO
							$^{239/240}Pu$	$4.4x10^0$	NO
116-K-2 (Process Effluent Trench)	133237	Varies (b)	Varies (b)	21625	Varies (b)	Soil/Sludge	Radionuclides	pCi/g	
							^{60}Co	$2.9x10^1$	NO
							^{137}Cs	$2.0x10^3$	NO
							^{152}Eu	$2.5x10^2$	NO
							^{154}Eu	$6.6x10^1$	NO
							$^{239/240}Pu$	$1.3x10^1$	NO
							^{90}Sr	$1.5x10^2$	NO
							^{228}Th	$1.1x10^0$	NO
							Inorganics	mg/kg	
							Chromium	$1.5x10^2$	YES
							Mercury	$3.9x10^0$	NO
116-KW-3 (Retention Basins)	275110	286	160	45100	6.0	Soil Sludge Concrete Steel	Radionuclides	pCi/g	
							^{60}Co	$1.4x10^2$	NO
							^{137}Cs	$1.6x10^2$	NO
							^{152}Eu	$4.6x10^2$	NO
							^{154}Eu	$1.7x10^2$	NO
							$^{239/240}Pu$	$8.3x10^0$	NO
							^{228}Th	$1.7x10^0$	NO
							^{232}Th	$1.4x10^0$	NO
							$^{233/234}U$	$1.7x10^1$	NO
							^{238}U	$1.7x10^1$	NO

Table M2-8. 100-KR-1 Operable Unit Waste-Site Profiles. (Page 2 of 2 sheets)

Waste Site (Group)	Extent of Contamination					Media/ Material	Refined COPCs	Maximum Concentration Detected (a)	Are Reduced Infiltration Concentrations Exceeded?
	Volume (m^3)	Length (m)	Width (m)	Area (m^2)	Thickness (m)				
116-KE-4 (Retention Basins)	159262	286	183	52389	3.0	Soil Sludge Concrete Steel	<u>Radionuclides</u> ^{60}Co ^{137}Cs ^{152}Eu ^{154}Eu $^{239/240}$Pu ^{228}Th ^{232}Th <u>Inorganics</u> Chromium	<u>pCi/g</u> 8.2×10^{2} 5.3×10^{3} 2.1×10^{4} 4.5×10^{3} 1.2×10^{1} 1.2×10^{0} 1.1×10^{0} 8.5×10^{1}	 NO NO NO NO NO NO NO YES
100-KR-1 Buried Process Effluent Pipelines	(c)	(c)	(c)	(c)	(c)	Steel Concrete	<u>Radionuclides(d)</u> ^{60}Co ^{137}Cs ^{152}Eu ^{154}Eu ^{155}Eu $^{239/240}$Pu	<u>pCi/g</u> assumed from Pipeline Group data	 NO NO NO NO NO NO

(a) Where concentration exceeds PRGs.
(b) Extent of contamination for 116-K-2 includes material inside and outside the trench. Inside trench: length = 1249.7 m, width = 13.7 m, depth = 7.6 m. Outside trench: contamination is a semicircular area with radius = 67.1 m and depth = 0.6 m.
(c) No soil contamination has been identified outside the pipelines; therefore no volume calculation is made. Extent of contamination is limited to within the pipeline itself.
(d) Based on 100-KR-1 QRA and consistent presence of Plutonium-239/240 at all waste-sites within 100-KR-1.

Table M2-9. Allowable Soil Concentration - Reduced Infiltration Scenario.

Analyte	Soil Concentration
RADIONUCLIDES	**pCi/g**
^{241}Am	5.01×10^{3}
^{14}C	2.92×10^{3}
^{134}Cs	8.35×10^{4}
^{137}Cs	1.25×10^{5}
^{60}Co	2.08×10^{5}
^{152}Eu	3.34×10^{6}
^{154}Eu	3.34×10^{6}
^{155}Eu	1.67×10^{7}
^{3}H	8.35×10^{4}
^{40}K	2.33×10^{4}
^{22}Na	3.34×10^{4}
^{63}Ni	7.52×10^{6}
^{238}Pu	8.35×10^{2}
$^{239/240}Pu$	6.27×10^{2}
^{226}Ra	4.00×10^{0}
^{90}Sr	2.09×10^{4}
^{99}Tc	4.18×10^{3}
^{228}Th	1.67×10^{1}
^{232}Th	2.09×10^{0}
$^{233/234}U$	8.35×10^{2}
^{235}U	1.00×10^{3}
^{238}U	1.00×10^{3}
INORGANICS	**mg/kg**
Antimony	2.51×10^{-1}
Arsenic	2.09×10^{0}
Barium	4.18×10^{4}
Cadmium	1.25×10^{2}
Chromium (VI)	4.18×10^{0}
Lead	1.25×10^{3}
Manganese	2.09×10^{3}
Mercury	5.01×10^{1}
Zinc	1.25×10^{5}
ORGANICS	**mg/kg**
Aroclor 1260	2.21×10^{2}
Benzo(a)pyrene	9.19×10^{7}
Chrysene	2.00×10^{0}
Pentachlorophenol	4.40×10^{1}

3.0 RESULTS OF THE PLUG-IN APPROACH

This Section describes how the analysis of remedial alternatives for the waste-site groups in the Process Document is used in lieu of doing independent analyses for the individual waste sites. The waste sites in the 100 Areas Source Operable Units were categorized into 10 waste-site groups, then several remedial alternatives for cleaning up each waste-site group were evaluated in the Process Document (see Sections 3.0, 4.0, and 5.0). To implement the "plug-in" approach, the first step is to identify which waste-site group an individual waste site at the 100-KR-1 Operable Unit to belong to. This is accomplished by comparing the profiles of the individual waste sites presented in Table M2-8 of this FFS to the waste-site group descriptions and group profiles given in Section 3.1 and Table 3-1 of the Process Document. The appropriate waste-site group for each site is identified in Table M3-1.

The next step is to determine if the individual waste-site characteristics meet the applicability criteria for the remedial alternatives for that waste-site group (see Table 4-2 in the Process Document). If the individual waste-site characteristics match the group profile and the applicability criteria completely, there are no deviations from the analysis in the Process Document. In this case, the analysis of alternatives in the Process Document is adequate for the individual waste site, and the individual waste site plugs into the existing alternatives analysis in the Process Document. If there are deviations, then further analyses of that waste site are conducted in Sections 4.0, 5.0, and 6.0 of this appendix.

The deviations indicated in Table M3-1 are briefly summarized as follows:

- Waste site 116-K-1 has contaminant concentrations less than the reduced infiltration concentrations, which is different from the Process Effluent Trench Group analyzed in the Process Document. Therefore, the Containment Alternative is considered as a possible interim Remedial Alternative for this site.

- Waste site 116-K-2 has contamination at depths that exceed the limit of 5.8 m (19 ft) for successful in situ treatment, which is inconsistent with the Process Effluent Trench Group analyzed in the Process Document. Therefore, the In Situ Treatment Alternative is not applicable for this waste site.

- Waste site 116-KW-3 has contaminant concentrations less than reduced infiltration concentrations, which is different from the Retention Basins Group analyzed in the Process Document. Therefore, the Containment Alternative is considered as a possible interim Remedial Alternative for this site.

- The contaminants at waste site 116-KE-4 do not exceed the limit of 5.8 m (19 ft) for successful in situ treatment, which is inconsistent with the Retention

Basins Group analyzed in the Process Document. Therefore, the In Situ Treatment Alternative is applicable at this waste site.

- The 100-KR-1 Buried Process Effluent Pipelines contain contaminants, but no leakage has been reported that would release contaminants to surrounding soils. Therefore, it is assumed that the soil surrounding the pipelines is not contaminated. This is different from the Pipeline Group analyzed in the Process Document. Therefore, the Removal/Treatment/Disposal Alternative is not applicable for the 100-KR-1 Buried Process Effluent Pipelines because no treatment of soils is necessary.

3.1 EXAMPLE OF THE PLUG-IN APPROACH

An example of implementing the plug-in approach for the 116-K-1 waste site is presented here to clarify the process. The process steps are described in Section 1.4 of the Process Document, and the example below illustrates steps 5 and 6 described in that Section.

The 116-K-1 Crib received liquid effluent from the reactor following fuel cladding failures as summarized in Table M2-2. The table also indicates that the site is 61 x 61 m (200 ft) with no indication of a gravel-filled structure. Because of its large size and lack of a gravel-filled structure, the site is not typical of a crib. The characteristics most resemble those of a process effluent trench (open excavation receiving contaminated reactor effluent). It can be concluded that the appropriate group for the 116-K-1 Crib is the process effluent trench. The profile for that group, and the associated detailed and comparative analyses, are documented in the Process Document.

The evaluation of the 116-K-1 waste site against each Remedial Alternative is presented below:

<u>No Action</u> - Data indicate that there is contamination present at the site that warrants action. Therefore, No Action is not an acceptable alternative.

<u>Institutional Controls</u> - Refined COPCs are identified for waste site 116-K-1 in Table M2-8 indicating that there are contaminants present that exceed PRGs. Therefore, Institutional Controls will not effectively address contaminants at the site.

<u>Containment</u> - None of the contaminants exceed reduced infiltration concentrations. Therefore, Containment may be applicable at the site.

<u>Removal/Disposal</u> - Contaminants in the soil at this site exceed PRGs. Therefore, this alternative may be applicable.

In Situ Treatment (Vitrification) - Contaminants in the soil at this site exceed PRGs, and the contaminated lens is < 5.8 m (19 ft). Therefore, the In Situ Treatment option may be applicable.

Removal/Treatment/Disposal (RTD) - Contaminants in the soil at this site exceed PRGs. Therefore, this alternative may be applicable. Thermal desorption enhancement is not necessary because organic contaminants are not present at the site. For cost purposes, it is assumed that none of the contaminated soil can be effectively treated by soil washing at the 116-K-1 waste site. This assumption is based on the depth, distribution, and concentration of contaminants present. This does not affect the application of the alternative, but does impact the magnitude of volume reduction that can be accomplished by the treatment process.

The 116-K-1 waste site characteristics outlined above are compared to the applicability criteria for the remedial alternatives shown in Table 4-2 of the Process Document. In addition to the three remedial alternatives listed in the Process Document for the Process Effluent Trench Group (Removal/Disposal, In Situ Treatment, and Remove/Treat/ Dispose), Containment is also found to be appropriate for this waste site. This deviation between the Process Document (Table 4-2) and the 116-K-1 waste site assessment is identified and noted in Table M3-1 of this FFS.

Because the applicable alternatives differ, further evaluation of the Containment Alternative is presented in Section 5.0 in this FFS.

3.2 RESULTS OF THE PLUG-IN APPROACH

The characteristics of the individual waste sites at the 100-KR-1 Operable Unit were compared to the applicability criteria for the remedial alternatives (as shown in Table 4-2 of the Process Document), and the results of this evaluation are shown in Table M3-1. The deviations between the individual waste sites and waste-site groups are noted in Table M3-1. None of the waste sites at the 100-KR-1 Operable Unit directly plug into their waste-site groups.

Table M3-1. Comparison of Waste Sites to Remedial Alternatives.

General Response Action and Alternative	Applicability Criteria and Enhancements	Waste Sites and Waste Site-Groups				
		116-K-1 Process Effluent Trench	116-K-2 Process Effluent Trench	116-KW-3 Retention Basins	116-KE-4 Retention Basins	100-KR-1 Buried Process Effluent Pipelines Pipelines
		Are Applicability Criteria and Enhancements Met?				
No Interim Action						
SS-1	Criterion: • Has site been effectively addressed in the past	No	No	No	No	No
Institutional Controls						
SS-2	Criterion: • Contaminants < PRG	No	No	No	No	No
Containment						
SS-3	Criteria: • Contaminants > PRG	Yes	Yes	Yes	Yes	Yes
	• Contaminants < reduced infiltration concentrations	Yes(d)	No	Yes(d)	No	Yes
Removal/Disposal						
SS-4	Criterion: • Contaminants > PRG	Yes	Yes	Yes	Yes	Yes
In Situ Treatment						
SS-8A (In Situ Vitrification)	Criteria: • Contaminants > PRG	Yes	Yes	Yes	Yes	NA
	• Contamination <5.8 m in depth	Yes	No(d)	No	Yes(d)	NA
SS-8B (Void Grouting)	Criteria: • Contaminants > PRG	NA	NA	NA	NA	Yes
	• Contaminants < reduced infiltration concentrations	NA	NA	NA	NA	Yes
Removal/Treatment/Disposal						
SS-10	Criterion: • Contaminants > PRG	Yes	Yes	Yes	Yes	NA (d)
	Enhancements: • Organic contaminants? (if yes, thermal desorption must be included in the treatment system)	No	No	No	No	NA (d)
	• Percentage of contaminated volume less than twice the PRG for cesium-137.	0%	33%	100%	67%	NA (d)

(d) - Deviation from waste-site group.
SS - Alternative prefix for soil sites.
NA - Not applicable.

4.0 ALTERNATIVE DEVELOPMENT

This section identifies those waste sites in the 100-KR-1 Operable Unit that match completely, or do not match, with their corresponding waste-site groups in the Process Document. Alternatives for the waste site do not require further development in this FFS if the waste site matches completely with the waste-site group profiles in the Process Document (Section 1.4, step 6a). However, none of the 100 KR-1 waste sites meet this requirement.

Waste sites that do not match completely (plug in directly) are divided into two groups. The first group consists of those sites that require enhancements to an alternative, or those sites where an alternative should be added or eliminated relative to what was considered for the waste-site group. The sites that meet this requirement, and the applicable deviations, are as follows:

- Waste site 116-K-1 does not match all of the applicability criteria for the Process Effluent Trench Group identified in the Process Document. In addition to meeting the criteria for the three alternatives identified in the Process Document, this site also meets the applicability criteria for the Containment Alternative because the concentrations of contaminants are less than the reduced infiltration concentrations. Accordingly, this waste site deviates from the waste-site group as a result of an additional alternative.

- Waste site 116-K-2 does not meet the applicability criteria for the In Situ Treatment Alternative because contamination exists at depths that exceed the alternative's limits. Accordingly, this waste site deviates from the waste-site group as a result of an eliminated alternative.

- Waste site 116-KW-3 does not match exactly with the applicability criteria for the Retention Basins Group identified in the Process Document. In addition to meeting the criteria for the two alternatives identified in the Process Document, this site also meets the applicability criteria for the Containment Alternative. The Containment Alternative is appropriate for 116-KW-3 because the concentrations of the contaminants are less than the reduced infiltration concentrations. Accordingly, this waste site deviates from the waste-site group as a result of an additional alternative.

- Waste site 116-KE-4 does not match exactly with the applicability criteria for the Retention Basins Group identified in the Process Document. In addition to meeting the criteria for the two alternatives identified in the Process Document, this site also meets the applicability criteria for the In Situ Treatment Alternative. The In Situ Treatment Alternative is appropriate for 116-KE-4 because all the contaminants are within a zone less than 5.8 m (19 ft) thick. The vitrification technique can successfully treat contaminants within that thickness. Accordingly, this waste site deviates from the waste-site group as a result of an additional alternative.

While In Situ Vitrification is applicable at the 116-KE-4 Retention Basins, it is not applicable at the 116-KW-3 Retention Basins because the contaminants at that site extend beyond the 5.8 m (19 ft) limit. In contrast, the Containment Alternative is applicable at 116-KW-3, but not at 116-KE-4, because the contaminants at the 116-KE-4 exceed the reduced infiltration concentrations.

- The 100-KR-1 Buried Pipelines do not meet the applicability criteria for the Removal/Treatment/Disposal Alternative because contaminated soil was not identified around the pipelines. Because a treatment process is not required, the Removal/Disposal Alternative accomplishes the same objectives as the Removal/Treatment/Disposal Alternative. Accordingly, this site deviates from the Pipeline Group because of an eliminated alternative.

The second group of waste sites that do not plug in are those sites that require a significant modification to an alternative, such as changes in the excavation process or disposal options. None of the waste sites within the 100-KR-1 Operable Unit fit into this second group. Therefore, additional alternative development, beyond that described above is not required.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents the detailed analysis of the remedial alternatives applicable to the individual waste sites within the 100-KR-1 Operable Unit. In the detailed analysis, each alternative is assessed employing the evaluation criteria described in Sections 5.1 and 5.2. The detailed analysis provides a basis to compare the alternatives and to support a subsequent evaluation of the alternatives that will be made by the decisionmakers during the remedy selection process.

A detailed analysis for each IRM waste site within the 100-KR-1 Operable Unit is presented below, because none of the individual waste sites in the 100-KR-1 Operable Unit plug directly into the analysis of alternatives of the waste-site groups presented in the Process Document. The remedial alternatives are evaluated based on their potential to impact various site resources and other human values (Section 5.1), and also based on the CERCLA evaluation criteria (Section 5.2).

5.1 SITE-SPECIFIC COMMON EVALUATION CONSIDERATIONS

This section supplements the analysis of alternatives in Section 5.2, meets the requirements of the DOE Secretarial Policy on NEPA, and identifies potential impacts on resources. Based on the evaluation presented in Table M3-1, none of the individual waste sites within the 100-KR-1 Operable Unit plug directly into the waste-site group alternatives. Therefore, the common evaluation considerations for waste sites 116-K-1, 116-K-2, 116-KW-3, 116-KE-4, and the 100-KR-1 Buried Pipelines are discussed in the following sections. Each deviation from the Process Document for these individual waste sites is analyzed for potential impacts to NEPA values (i.e., transportation, air quality, ecological, cultural, socioeconomic, noise, and visual resources). In addition, the irretrievable and irreversible commitment of resources, indirect and cumulative impacts, and compliance with the Executive Order 12898 on Environmental Justice are also discussed.

5.1.1 116-K-1 Crib

This section evaluates the alternatives that deviate from the Process Document for waste site 116-K-1 Crib. Alternatives SS-3, SS-4, SS-8A, and SS-10 (Containment, Removal/Disposal, In Situ Verification, and Removal/Treatment/Disposal, respectively) are applicable to this site, and three of these four were analyzed in the Process Document. Only Alternative SS-3, containment of contaminated soil, deviates from the Process Document and is evaluated below.

5.1.1.1 Transportation. Alternative SS-3 will have some impact on transportation. This alternative will require transporting equipment, barrier construction material, and personnel to the site, and importing clean fill from borrow areas within the Hanford Site. The traffic associated with this alternative is not expected to cause a noticeable impact in the Tri-Cities area or on the Hanford Site.

5.1.1.2 Air Quality. Air quality, except for fugitive dust, will not be impacted by Alternative SS-3 because contaminated soil will not be disturbed. Rather, clean fill will be placed over the contaminated area. Measures will be implemented to control fugitive dust.

5.1.1.3 Ecological. Ecological resources will not be impacted long term. In fact, revegetation and restoration efforts will benefit natural resources in the long term.

5.1.1.4 Cultural. Impacts to cultural resources located near the 116-K-1 Crib area will generally be minimized by this alternative. Cultural resources are not expected to occur within the crib area itself; therefore, the potential for this alternative to disturb cultural resources is considered low. However, cultural resources, if present, would be left in place within the contaminated soil by this alternative. This would be a continuing source of concern to Native American communities.

5.1.1.5 Socioeconomic. The socioeconomic impact of this alternative will be insignificant. The number of employees involved and the income gained will be negligible when compared with the total Tri-Cities area employment. Workers will likely come from the regional labor force. Therefore, income and population impact effects on housing will be inconsequential.

5.1.1.6 Noise and Visual Resources. This alternative will create minor short-term noise and visual resource impacts, and minor long-term impacts to visual resources. Noise levels will increase above current levels during implementation of the Containment Alternative. Mitigation measures will be provided to control noise levels. Contouring to closely match the existing ground contour, and revegetating or stabilizing the site will mitigate potential impacts to visual resources.

5.1.1.7 Irretrievable and Irreversible Commitment of Resources. This alternative will result in the commitment of land at the 100-KR-1 Operable Unit for waste-management. Institutional controls and monitoring will be required because wastes will be left at the site. Resources (such as federal funds and soil cover), consumables (such as fuel, electricity, and chemicals), and personal protective equipment will be irreversibly committed.

5.1.1.8 Indirect and Cumulative Impacts. The indirect impact of this alternative will be improved conditions at the site to support natural resources, through revegetation of the remediated waste site. Alternative SS-3 could add to cumulative impacts on transportation, noise, ecological resources, and visual resources if this site is remediated concurrently with several other sites within the 100 Areas.

5.1.1.9 Compliance with Executive Order 12898. As stated in Section 5.2.6.5 of the Process Document, this alternative complies with Executive Order 12898, Environmental Justice, because it will not disproportionately affect any group of the population more than another.

5.1.2 116-K-2 Process Effluent Trench

The In Situ Treatment Alternative is not applicable to the 116-K-2 Process Effluent Trench because contaminants occur at depths below the effective range of the in situ vitrification process. Since the deviation from the Process Document, relative to this waste site, is just the elimination of one of the three alternatives applicable to this waste-site group, no further analysis is required.

5.1.3 116-KW-3 Retention Basins

This section evaluates the alternatives that deviate from the Process Document for the 116-KW-3 Retention Basins waste site. Alternatives SS-3, SS-4, and SS-10 (Containment, Removal/Disposal, and Removal/Treatment/Disposal, respectively) are applicable to this site. Only Alternative SS-3, containment of contaminated soil, deviates from the Process Document and is evaluated below.

5.1.3.1 Transportation. Alternative SS-3 will have some impact on transportation. This alternative will require transporting equipment, barrier construction material, and personnel to the site, and importing clean fill from borrow areas within the Hanford Site. The traffic associated with this alternative is not expected to cause a noticeable impact in the Tri-Cities area or on the Hanford Site.

5.1.3.2 Air Quality. Air quality, except for fugitive dust, will not be impacted by Alternative SS-3 because contaminated soil will not be disturbed. Rather, clean fill will be placed over the contaminated area. Measures will be implemented to control fugitive dust.

5.1.3.3 Ecological. Ecological resources will not be impacted long term. In fact, revegetation and restoration efforts will benefit natural resources in the long term.

5.1.3.4 Cultural. Impacts to cultural resources located near the Retention Basins will generally be minimized by this alternative. Cultural resources are not expected to occur within the basin area itself; therefore, the potential for this alternative to disturb cultural resources is considered low. However, cultural resources, if present, would be left in place within the contaminated soil. This may be a continuing source of concern to Native American communities.

5.1.3.5 Socioeconomic. The socioeconomic impact of this alternative will be insignificant. The number of employees involved and the income gained will be negligible when compared with the total Tri-Cities area employment. Workers will likely come from the regional labor force. Therefore, income and population impact effects on housing will be inconsequential.

5.1.3.6 Noise and Visual Resources. This alternative will create minor short-term noise and visual resource impacts, and minor long-term impacts to visual resources. Noise levels will increase above current levels during implementation of the containment alternative.

Noise mitigation will be provided to control noise levels. Contouring to closely match the existing ground contour, and revegetating or stabilizing the site will mitigate potential impacts to visual resources.

5.1.3.7 Irretrievable and Irreversible Commitment of Resources. This alternative will result in the commitment of land at the 100-KR-1 Operable Unit for waste-management. Institutional controls and monitoring will be required because wastes will be left at the site. Resources (such as federal funds and soil cover), consumables (such as fuel, electricity, and chemicals), and personal protective equipment will be irreversibly committed.

5.1.3.8 Indirect and Cumulative Impacts. The indirect impact of this alternative will be improved conditions at the site to support natural resources, through revegetation of the remediated waste site. Alternative SS-3 could add to cumulative impacts on transportation, noise, ecological resources, and visual resources if this site is remediated concurrently with several other sites within the 100 Areas.

5.1.3.9 Compliance with Executive Order 12898. As stated in Section 5.2.6.5 of the Process Document, this alternative complies with Executive Order 12898, Environmental Justice, because it will not disproportionately affect any group of the population more than another.

5.1.4 116-KE-4 Retention Basins

This section evaluates the alternatives that deviate from the Process Document for the 116-KE-4 Retention Basins waste site. Alternatives SS-4, SS-8A, and SS-10 (Containment, In Situ Vitrification, and Removal/Treatment/Disposal, respectively) are applicable to this site. Only Alternative SS-8A, in situ treatment of soil, deviates from the Process Document and is evaluated below.

5.1.4.1 Transportation. Alternative SS-8A, in situ vitrification, will have some impact on transportation. This alternative will require transporting special equipment to the site, removing solid waste from operations, and importing clean fill from borrow areas within the Hanford Site after treatment. The traffic associated with this alternative is not expected to cause a noticeable impact in the Tri-Cities area or on the Hanford Site.

5.1.4.2 Air Quality. Air quality will not be impacted by Alternative SS-8A in the short term, except for fugitive dust during placement of clean fill. The 116-KE-4 Retention Basins is not known to have organic contaminants, so the emission of organic compounds during vitrification should not be a problem. Mitigation measures will be employed as needed to ensure that short-term impacts on air quality are controlled.

5.1.4.3 Ecological. Ecological resources would not be impacted in the long term. In fact, revegetation and restoration efforts would benefit natural resources in the long term.

5.1.4.4 Cultural. Impacts to cultural resources located near the Retention Basins will generally be minimized by this alternative. Cultural resources are not expected to occur within the basin area itself. However, cultural resources, if present, would be left within the vitrified mass, and this may be a concern to Native American communities within the basin.

5.1.4.5 Socioeconomic. The socioeconomic impact of this alternative will be insignificant. The number of employees involved and the income gained will be negligible when compared with the total Tri-Cities area employment. Workers will likely come from the regional labor force. Therefore, income and population impact effects on housing will be inconsequential.

5.1.4.6 Noise and Visual Resources. This alternative will create minor short-term noise and visual resource impacts, and minor long-term impacts to visual resources. Noise levels will increase above current levels during the in situ treatment process. Noise mitigation will be provided to control noise levels. Dust control, backfilling with clean soil, contouring to closely match existing ground contour, and revegetating or stabilizing the site will mitigate potential impacts to visual resources.

5.1.4.7 Irretrievable and Irreversible Commitment of Resources. This alternative will result in the commitment of land at the 100-KR-1 Operable Unit for waste management. Institutional controls and monitoring will be required because wastes will be left at the site. Resources (such as federal funds and soil cover), consumables (such as fuel, electricity, and chemicals), and personal protective equipment will be irreversibly committed.

5.1.4.8 Indirect and Cumulative Impacts. The indirect impact of this alternative will be improved conditions at the site to support natural resources, through revegetation or stabilization of the remediated waste site. Alternative SS-8A could add to cumulative impacts on transportation, noise, ecological resources, and visual resources if the site is remediated concurrently with several other sites within the 100 Areas.

5.1.4.9 Compliance with Executive Order 12898. As stated in Section 5.2.6.5 of the Process Document, this alternative complies with Executive Order 12898, Environmental Justice, because it will not disproportionately affect any group of the population more than another.

5.1.5 100-KR-1 Buried Process Effluent Pipelines

The Removal/Treatment/Disposal Alternative is not applicable to the 100-KR-1 Buried Process Effluent Pipelines because contaminants are not known to occur within the soil surrounding the pipelines. The Removal/Disposal Alternative, therefore, will accomplish the same remedial objectives. Since the deviation from the Process Document, relative to the pipelines, is just an elimination of one of the four alternatives applicable to this waste-site group, no further analysis is required.

5.2 SITE-SPECIFIC DETAILED ANALYSIS

Based on the comparisons presented in Table M3-1, none of the individual waste sites within the 100-KR-1 Operable Unit plug into the waste-site group alternatives. The detailed analyses for 116-K-1, 116-K-2, 116-KW-3, 116-KE-4, and the 100-KR-1 Buried Pipelines waste sites are discussed in the following sections and summarized in Table M5-1. Tables M5-2 and M5-3 present the estimated remediation costs and durations associated with all waste sites.

5.2.1 116-K-1 Crib

There are four remedial alternatives applicable for the 116-K-1 Crib waste site, which belongs in the Process Effluent Waste-Site Group. These four are Containment (SS-3), Removal/Disposal (SS-4), In Situ Vitrification (SS-8A), and Removal/Treatment/Disposal (SS-10). The latter three alternatives were evaluated in Section 5.3 of the Process Document. Only Alternative SS-3 deviates from the Process Document.

5.2.1.1 Overall Protection of Human Health and the Environment. Alternative SS-3 consists of physical measures to restrict contaminant migration. The Hanford Barrier is the appropriate technology to implement at site 116-K-1. Alternative SS-3 will reduce or eliminate risk by installing an engineered barrier over the contaminated material. However, the contaminated material remains at the site. Cultural resources, if present, could be impacted.

5.2.1.2 Compliance with ARARs. Chemical-specific ARARs applicable to Alternative SS-3 are met by meeting remedial action objectives, which are based on ARARs. These ARARs are also met by eliminating exposure pathways. Location-specific ARARs are met through proper planning and scheduling. Action-specific ARARs are met through appropriate design and operation.

5.2.1.3 Long-term Effectiveness and Permanence. The magnitude of the remaining risk for Alternative SS-3 is minimal because there is no exposure to the contaminated waste. Although contaminants remain at the site, the potential exposure pathways are eliminated. Long-term, post-closure monitoring of the engineered barrier is required, and repair and maintenance will be necessary. In addition, groundwater surveillance monitoring will be conducted as part of the groundwater operable unit to check the long-term integrity of the Containment Alternative.

5.2.1.4 Reduction of Toxicity, Mobility, or Volume. Treatment is not proposed. Therefore, reduction in toxicity or volume is not achieved. Contaminants are effectively immobilized by the engineered barrier by reducing hydraulic infiltration. Radionuclides present in the contaminated material will degrade naturally.

5.2.1.5 Short-term Effectiveness. Risks to the community and workers during construction of the barrier include the potential release of fugitive dust and gas. Releases can be controlled through proper operating procedures. Remedial activities can be scheduled to avoid disturbing bald eagles (winter residents) and spring-nesting species. Soil excavation may impact terrestrial species in the short term, and activities near the river may impact aquatic and wetland species.

5.2.1.6 Implementability. Some investigation will be required to locate the area proposed for treatment. It is unlikely that technical problems will cause schedule delays. The Hanford Barrier is a demonstrated technology. All necessary equipment and barrier material are readily available. Long-term deed restrictions may require coordination with state groundwater agencies and local zoning authorities.

5.2.2 116-K-2 Process Effluent Trench

Further analysis of remedial alternatives for the 116-K-2 Process Effluent Trench is not required. Three alternatives were evaluated in the Process Document for the Process Effluent Trench Group, and two of these three are applicable for the 116-K-2 Site. Because the deviation from the Process Document is only the elimination of the In Situ Treatment Alternative, no further analysis is required.

5.2.3 116-KW-3 Retention Basins

This section evaluates the Containment Alternative for the 116-KW-3 Retention Basins. There are three remedial alternatives applicable for this waste site, which belongs in the Retention Basins Waste-Site Group. These are Containment (SS-3), Removal/Disposal (SS-4), and Removal/Treatment/Disposal (SS-10). The latter two alternatives were evaluated in Section 5.3 of the Process Document. Only Alternative SS-3 deviates from the Process Document.

5.2.3.1 Overall Protection of Human Health and the Environment. Alternative SS-3 consists of physical measures to restrict contaminant migration. The Hanford Barrier is the appropriate technology to implement at site 116-KW-3. Alternative SS-3 will reduce or eliminate risk by installing an engineered barrier over the contaminated material. However, the contaminated material remains at the site. Cultural resources, if present, could be impacted.

5.2.3.2 Compliance with ARARs. Chemical-specific ARARs applicable to Alternative SS-3 are met by meeting remedial action objectives, which are based on ARARs. These ARARs are also met by eliminating exposure pathways. Location-specific ARARs are met through proper planning and scheduling. Action-specific ARARs are met through appropriate design and operation.

5.2.3.3 Long-term Effectiveness and Permanence. The magnitude of the remaining risk for Alternative SS-3 is minimal because no exposure to the contaminated waste exists. Although contaminants remain at the site, the potential exposure pathways are eliminated. Long-term, post-closure monitoring of the engineered barrier is required, and repair and maintenance will be necessary. In addition, groundwater surveillance monitoring will be conducted as part of the groundwater operable unit to check the long-term integrity of the Containment Alternative.

5.2.3.4 Reduction of Toxicity, Mobility, or Volume. Treatment is not proposed. Therefore, reduction in toxicity or volume is not achieved. Contaminants are effectively immobilized by the engineered barrier by reducing hydraulic infiltration. Radionuclides present in the contaminated material will degrade naturally.

5.2.3.5 Short-term Effectiveness. Risks to the community and workers during construction of the barrier include the potential release of fugitive dust and gas. Releases can be controlled through proper operating procedures. Remedial activities can be scheduled to avoid disturbing bald eagles (winter residents) and spring-nesting species. Soil excavation may impact terrestrial species, and activities near the river may impact aquatic and wetland species.

5.2.3.6 Implementability. Some investigation will be required to locate the area proposed for treatment. It is unlikely that technical problems will cause schedule delays. The Hanford Barrier is a demonstrated technology. All necessary equipment and barrier material are readily available. Long-term deed restrictions may require coordination with state groundwater agencies and local zoning authorities.

5.2.4 116-KE-4 Retention Basins

This section evaluates the In Situ Vitrification Alternative for the 116-KW-4 Retention Basins. There are three alternatives applicable for this waste site, which belongs in the Retention Basin Waste-Site Group. These three alternatives are Removal/Disposal (SS-4), In Situ Vitrification (SS-8A), and Removal/Treatment/Disposal (SS-10). The SS-4 and SS-10 alternatives were evaluated in Section 5.3 of the Process Document. Only Alternative SS-8A deviates from the Process Document.

5.2.4.1 Overall Protection of Human Health and the Environment. Alternative SS-8A involves in situ vitrification to thermally treat organic contaminants and immobilize inorganic contaminants at the 116-KE-4 Retention Basins. Alternative SS-8A will reduce or eliminate risk by encapsulating contaminated material in a vitrified mass. The encapsulated material remains at the site. Workers will not be exposed to contaminants in soils during implementation, and operational controls will minimize the potential for exposure to contaminants in off-gas.

5.2.4.2 Compliance with ARARs. Chemical-specific ARARs applicable to Alternative SS-8A are met by thermal destruction and encapsulation of contaminants in the soil. Location-specific ARARs are met through proper planning and scheduling. Action-specific ARARs are met through appropriate design and operation.

5.2.4.3 Long-term Effectiveness and Permanence. The magnitude of the remaining risk for Alternative SS-8A is minimal because exposure to the contaminated waste is eliminated. Although sources of risk remain, the potential exposure pathways are removed. Long-term, post-closure monitoring of the encapsulated material and groundwater is required. In addition, maintenance of the soil cover overlying the vitrified material may be necessary.

5.2.4.4 Reduction of Toxicity, Mobility, or Volume. In situ vitrification is an irreversible process that will treat all of the contaminated soil to the maximum melt depth, effectively immobilizing the contaminants in the glass melt. Hydraulic infiltration is reduced and mobilization is eliminated. There will be small quantities of residual contamination from off-gas treatment in condensate and contaminated filters. However, these can be disposed of directly into the melt. The principal exposure pathways at the site are eliminated. Radionuclides present in the contaminated material will degrade naturally.

5.2.4.5 Short-term Effectiveness. Risks to the community and workers during in situ vitrification of contaminated material include the potential release of fugitive dust and off-gas during treatment. Releases can be controlled by using proper operating procedures. Remedial activities can be scheduled to avoid disturbing bald eagles (winter residents) and spring-nesting species.

5.2.4.6 Implementability. Investigations will be required to locate the area proposed for treatment and characterize the soils within the site. Soil particle size may vary from site to site, and existence of cobble layers or structural members may affect performance. It is unlikely that technical problems will lead to schedule delays. All necessary equipment and specialists are readily available. Long-term deed restrictions may require coordination with state groundwater agencies and local zoning authorities.

5.2.5 100-KR-1 Buried Process Effluent Pipelines

Further analysis of remedial alternatives for the 100-KR-1 Buried Process Effluent Pipelines is not required. Four alternatives were evaluated in the Process Document for the Buried Process Effluent Pipeline Group, and three of these four are applicable for the 100-KR-1 Buried Process Effluent Pipelines (Containment [SS-3], Removal/Disposal [SS-4], and Void Grouting [SS-8B]). The Removal/Treatment/Disposal Alternative (SS-10) is not applicable to the buried process effluent pipelines because current documentation indicates that the soil surrounding the pipelines is not contaminated. Therefore, the soil surrounding the pipelines will not require treatment. Because the deviation from the Process Document is only the elimination of the SS-10 Alternative, no further analysis is required.

Table M5-1. Waste Site Remedial Alternatives and Technologies.

Alternatives	Waste Sites				
	116-K-1	116-K-2	116-KW-3	116-KE-4	100-KR-1 Pipelines
No Interim Action SS-1	NA	NA	NA	NA	NA
Institutional Controls SS-2	NA	NA	NA	NA	NA
Containment SS-3	P,O	NA	P,O	NA	P
Removal/Disposal SS-4	P	P	P	P	P
In Situ Treatment SS-8A (SS-8B for Pipelines)	P	NA	NA	P,O	P
Removal/Treatment/Disposal SS-10	P	P	P	P	NA

A "P" or an "O" in the waste site column indicates that the alternative is applicable to that site.
P - Detailed analysis is provided in the main text of the Process Document.
O - Detailed analysis is discussed further in this appendix.
NA - Not applicable.

Table M5-2. 100-KR-1 Site-Specific Alternative Costs.

Site	Containment			Removal/Disposal			In Situ Treatment			Removal/Treatment/Disposal		
	Capital	Total O&M	Present Worth	Capital	Total O&M	Present Worth	Capital	Total O&M	Present Worth	Capital	Total O&M	Present Worth
100-KR-1 Operable Unit												
116-K-1	$7.51E+06	$2.35E+06	$8.47E+06	$3.30E+06	$0.00E+00	$3.15E+06	$7.99E+06	$6.24E+06	$1.36E+07	$3.30E+06	$0.00E+00	$3.15E+06
116-K-2				$6.85E+07	$0.00E+00	$6.34E+07				$6.82E+07	$9.72E+06	$7.11E+07
116-KW-3	$3.69E+07	$1.76E+07	$4.38E+07	$9.05E+07	$0.00E+00	$8.49E+07				$8.66E+07	$2.74E+07	$1.03E+08
116-KE-4				$2.27E+07	$0.00E+00	$2.17E+07	$6.46E+07	$5.04E+07	$8.76E+07	$2.25E+07	$4.83E+06	$2.61E+07
100-KR-1 Pipelines	$3.73E+07	$1.80E+07	$4.46E+07	$4.27E+07	$0.00E+00	$3.98E+07	$8.26E+06	$0.00E+00	$7.87E+06			

Blank cell = not applicable

Table M5-3. 100-KR-1 Site-Specific Alternative Durations.

Site	Containment	Removal/ Disposal	In Situ Treatment	Removal/Treatment/ Disposal
	Duration (yrs)	Duration (yrs)	Duration (yrs)	Duration (yrs)
116-K-1 Crib	0.6	0.2	1.1	0.2
116-K-2 Process Effluent Trench		4.2		5.1
116-KW-3 Retention Basins	4.0	2.8		6.5
116-KE-4 Retention Basins		0.4	10.5	0.7
100-KR-1 Buried Process Effluent Pipelines	1.7	1.7	0.2	

Blank cell = not applicable

6.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

As discussed in the introduction of this FFS, the detailed and comparative analyses performed in Sections 5.0 and 6.0 of the Process Document were based on meeting human health risk-based goals. Those risk-based goals assumed a land use that included occasional use of the land and remediation of the soil to support frequent use of groundwater. This scenario is referred to as the Baseline Scenario. The detailed analysis of alternatives in Section 5.0 of this FFS is also conducted using the Baseline Scenario. The comparative analysis of alternatives in this section, however, is conducted using a Revised Scenario, because of a recent agreement among EPA, Ecology, and DOE.

The public has provided input to DOE on the future land use of the 100 Areas through various forms, including the Hanford Future Site Uses Working Group (DOE-RL 1992c). However, the final land use for the 100 Areas has yet to be established. As a result, EPA, Ecology and DOE recently agreed to interim cleanup goals at source Operable Units that will not limit any future uses of the 100 Areas. This will provide for IRMs that are consistent with possible final actions, and permit the determination of final action at a future date. Hanford Site uses, relative to final action, could potentially range from maintaining wildlife refuges to developing portions of the Hanford Site for industrial or residential purposes.

Based on the above agreement among the Tri-Party signatory agencies, the cleanup goals for the comparative analysis of alternatives in this FFS are based on different assumptions regarding land use than those used in the Process Document. The remediation goals for the comparative analysis in this FFS assume soil remediation to support unrestricted use of the land and protection of groundwater depending upon the current quality of the groundwater underlying the waste site. This cleanup concept is referred to as the Revised Scenario, and is based on three laws and the draft legislation listed below.

- State of Washington *Model Toxics Control Act* for organic and inorganic chemical constituents in soil to support unrestricted (residential) use.

- Draft EPA and Nuclear Regulatory Commission guidance proposal of a human health standard of 15 mrem/year above background for radionuclides in soils.

- Protection of groundwater, such that contaminants remaining in the soil after remediation do not result in an impact to groundwater that could exceed Maximum Contaminant Levels under the *Safe Drinking Water Act*. (This applies to waste sites where groundwater has not been impacted.)

- Protection of the Columbia River, such that contaminants remaining in the soil after remediation do not result in an impact to groundwater and, therefore, the Columbia River that could exceed the Ambient Water Quality Criteria for the protection of aquatic organisms under the *Clean Water Act*. (This applies to sites where groundwater has already been impacted.)

6.1 INFLUENCE OF THE REVISED CLEANUP GOALS ON THIS FFS

Because the comparative analysis of alternatives in this FFS is preceded by, and closely interrelated with, the original development of the alternatives in the *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL 1993a) and the detailed and comparative analysis of alternatives in the *100 Area Source Operable Unit Focused Feasibility Study* (the Process Document), the effect of changing cleanup goals must be carefully considered. This is especially true since the analysis of alternatives for waste-site groups in the Process Document is used in this FFS if the individual waste site matches with a waste-site group. The following subsections discuss the possible effects of changing from the Baseline Scenario to the Revised Scenario.

6.1.1 Development of Alternatives

The development of the remedial alternatives in the *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL 1993a), and the refinement of those alternatives in the Process Document are not influenced by the change in cleanup goals. The EPA guidance for CERCLA feasibility studies (EPA 1988) requires a range of alternatives be developed to address a variety of remedial options ranging from No Action to Treatment. The remedial alternatives developed in the *100 Areas Feasibility Study Phases 1 and 2* and in the Process Document are appropriate for both the Baseline Scenario and the Revised Scenario.

6.1.2 The Plug-In Approach

The change in cleanup goals does not alter the fact that many of the waste sites within the 100 Areas of the Hanford Site are similar to each other. Therefore, the approach of using a waste-site group to represent individual waste sites that are similar to each other remains valid, and the plug-in approach used in this FFS remains directly applicable under the Revised Scenario.

6.1.3 Detailed Analysis of Alternatives

The detailed analysis of alternatives conducted in Section 5.0 of the Process Document and in Section 5.0 of this FFS evaluated the alternatives with respect to CERCLA criteria and NEPA values. The change in cleanup goals influences these analyses to some extent because the evaluation is based on the potential of each alternative to attain the cleanup goals. However, the detailed analysis of alternatives under both the Baseline Scenario and the Revised Scenario involves assessing the ability of alternatives to meet risk-based goals linked to COPCs in soil, and to meet protection of groundwater criteria. Likewise, the potential adverse effects of implementing the alternatives on workers, future site uses, and the environment are also much the same under the Baseline Scenario and the Revised Scenario. Therefore, the detailed analyses of alternatives in the Process Document and in Section 5.0 of this 100-KR-1 FFS remain valid.

6.1.4 Number of Remedial Alternatives

The agreement between EPA, Ecology, and DOE to refrain from selecting interim remedial measures that would limit the potential future uses of the 100 Areas does effect the number of alternatives considered in the comparative analysis of alternatives. The remedial alternatives that would leave contaminants at the individual waste sites, such as the In Situ Treatment and Containment Alternatives, would limit potential future uses, and are therefore not appropriate alternatives for interim action under the Revised Scenario. The presence of contaminants, even if vitrified or under a barrier, would preclude some of the potential future uses of the 100 Area. The comparative analysis of alternatives conducted for this FFS (see Section 6.2), therefore, does not consider the In Situ Treatment Alternative or the Containment Alternative.

6.1.5 Extent of Removal

During the development of the Process Document, DOE evaluated the ramifications of remediating waste sites to meet cleanup goals different from those developed under the Baseline Scenario. This evaluation was part of a Sensitivity Analysis (Appendix D) that evaluated the effects of different cleanup goals on costs and engineering feasibility, using remedial alternatives similar to those considered in the Process Document. The Sensitivity Analysis included updating some of the input parameters for the Summers Model, to incorporate knowledge gained about site conditions. The Summers Model is used to establish remediation goals for protection of groundwater. This updating process indicated that less excavation will be required during the Removal/Disposal and Removal/Treatment/Disposal Alternatives than was estimated during the analysis of alternatives in the Process Document (see the Sensitivity Analysis, Appendix D). Therefore, during the comparative analysis of alternatives conducted for this FFS, appropriate adjustments were made to account for the reduced excavation requirements, and the reduced costs associated with less excavation. Costs for the Removal/Disposal and Removal/Treatment/Disposal Alternatives are reduced 30.8 and 35.5%, respectively, as compared to the Baseline Scenario (see Tables 5-33 and 5-34 of Attachment 5 of the Sensitivity Analysis).

6.1.6 Treatment Concepts

The removal and disposal components of the Removal/Disposal Alternative and the Removal/Treatment/Disposal Alternative are essentially the same. The removal technologies used will depend on the waste site characteristics, and both alternatives assume that the contaminated material will be disposed of at the Hanford Site ERDF. These two alternatives, therefore, differ primarily because of the treatment components. There is one treatment component that is an integral part of both alternatives; and that is treatment, if necessary, to meet Land Disposal Restrictions (LDR). Treatment for LDR is an ARAR for all disposal alternatives, and that treatment (if required) is to be performed before disposal of any wastes that exceed concentration limits specified in the regulations. Based on the information currently available, LDR treatment will be required for a limited number of contaminants. Because of the uncertainties associated with the LDR treatment volumes, a detailed analysis of costs for LDR treatment could not be performed as part of this FFS. However, it is expected that LDR treatment costs for both the Removal/Disposal and the Removal/Treatment/Disposal Alternatives would be essentially the same and would, thus, not be a discriminating factor to determine which of these two alternatives would be more appropriate as an IRM.

The Removal/Treatment/Disposal Alternative includes treatment that would be conducted to reduce the volume of contaminated material requiring disposal, treatment that would be conducted to reduce the eventual size of the ERDF, or treatment that would be conducted to improve the cost-effectiveness of operations. Treatment by soil washing will be conducted to reduce the volume of contaminated soil for disposal. However, the application of soil washing at a waste site will depend on several factors, including soil conditions, contaminant-specific cleanup goals, and the concentrations and types of contaminants present. Soil washing is a desirable treatment only when the contaminated volume can be significantly reduced, and only when such volume reduction is cost-effective. The greatest cost benefit would be achieved at large-volume sites with low levels of contaminants. Treatability studies are in progress to evaluate the effectiveness of soil washing at the 100 Areas.

6.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

There were six remedial alternatives originally considered as potential IRMs at the 100-KR-1 Operable Unit (Table M3-1). The No Action and Institutional Controls Alternatives were eliminated because neither would adequately address the contamination present at this Operable Unit. The Containment and In Situ Treatment Alternatives were also eliminated from consideration because of the recent agreement between EPA, Ecology, and DOE to consider only those IRMs that will not limit the potential future uses of the 100 Areas. Therefore, only two remedial alternatives remain to be considered in this comparative analysis: the Removal/Disposal and Removal/Treatment/Disposal Alternatives.

The comparative analysis of these two alternatives indicates that the Removal/Disposal Alternative is best with respect to short-term effectiveness and implementability. This alternative would pose less risk to workers because treatment activities would be limited to meeting LDR exposure to contaminated soil or treatment chemicals would be minimized, and disturbance at the waste site would be less because space for treatment operations and equipment would not be needed (except to meet LDR). The Removal/Disposal Alternative would also be easier to implement because only limited treatment activities (to meet LDR) would be necessary. Less time would be required to complete the Removal/Disposal Alternative than the Removal/Treatment/Disposal Alternative.

The Removal/Treatment/Disposal Alternative, however, would be the best alternative with respect to long-term effectiveness and would reduce the mobility and volume of the contaminated material. The treatment activities would reduce the volume of contaminated material requiring disposal at the ERDF. Treatment activities, such as soil washing, would also provide clean material that could be used to backfill excavated areas, thereby reducing the amount of fill that would be required from borrow areas in uncontaminated areas of the Hanford Site. Because the treatment technologies included in the Removal/Treatment/Disposal Alternative are primarily physical, and the contaminants of concern are primarily radionuclides and inorganic elements, the toxicity of the contaminants will not be reduced. However, the reduction in the volume of contaminated wastes, and the reduction in mobility from disposing the wastes at ERDF, will provide long-term effectiveness (see Section 4.1.6 in the Process Document). The Removal/Treatment/Disposal Alternative satisfies the preference for remedies that employ treatment as a principal element required by CERCLA. Because of current uncertainties in disposal costs, transportation, and treatment efficiencies, the cost differences between the Removal/Disposal and Removal/Treatment/Disposal Alternatives are not considered an important factor to discriminate between the two alternatives.

Significant uncertainties remain in treatment options, future land use, actual contamination present at each site, and the mechanics of remediation activities on an Operable Unit scale. Thus, the comparative evaluation of the alternatives has been primarily qualitative.

7.0 REFERENCES

Cadwell, L. L., 1994, *Wildlife Studies on the Hanford Site: 1993 Highlights Report*, PNL-9380, Pacific Northwest Laboratory, Richland, Washington.

Chatters, J. C., H. A. Gard, and P. E. Minthorn, 1992, *Fiscal Year 1991 Report on Archaeological Surveys of the 100 Areas Hanford Site, Washington*, PNL-8143, Pacific Northwest Laboratory, Richland, Washington.

DOE-RL, 1991, *Hanford Past-Practice Strategy*, DOE/RL-91-40, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1992a, *Remedial Investigation/Feasibility Study Work Plan for the 100-KR-1 Operable Unit*, DOE/RL-90-20, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1992b, *Remedial Investigation/Feasibility Study Work Plan for the 100-KR-4 Operable Unit*, DOE/RL-90-20, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1992c, *Hanford Future Site Uses Working Group, Future for Hanford: Uses and Cleanup*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993a, *100 Areas Feasibility Study Phases 1 and 2*, DOE/RL-92-11, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993b, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Rev. 1, Draft, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994a, *Limited Field Investigation Report for the 100-KR-1 Operable Unit*, DOE/RL-93-78, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994b, *100 Areas River Effluent Pipelines Expedited Response Action Proposal*, DOE/RL-94-79, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994c, *100-KR-4 Operable Unit Focused Feasibility Study Report*, DOE/RL-94-48, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994d, *Columbia River Impact Evaluation Plan*, DOE/RL-92-28, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland Operations Office, Richland, Washington.

DOE-RL, 1995a, *100 Area Source Operable Unit Focused Feasibility Study Report*, DOE/RL-94-61, Rev. 0, Vol. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1995b, *Hanford Site Risk Assessment Methodology*, DOE/RL-91-45, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Dorian, J. J., and V. R. Richards, 1978, *Radiological Characterization of the Retired 100 Areas*, UNI-946, United Nuclear Industries, Inc., Richland, Washington.

Ecology, EPA, and DOE-RL, 1994, *Hanford Federal Facility Agreement and Consent Order*, Fourth Amendment, January 1994, Washington State Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, Region X, Seattle, Washington, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, Interim Final, U.S. Environmental Protection Agency, Washington D.C.

EPA 1989, *Risk Assessment Guidance for Superfund, Vol. 1, Human Health Evaluation Manual (Part A)*, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D.C.

Fitzner, R. E. and R. L. Newell, 1989, *Ferruginous Hawk Nesting on the U.S. DOE Hanford Site: Case History of a Recent Invasion Caused by Transmission Lines*, PNL-SA-16300, Pacific Northwest Laboratory, Richland, Washington.

Fitzner, R. E. and S. G. Weiss, 1994, *Bald Eagle Site Management Plan for the Hanford Site, South Central Washington*, WHC-EP-0510, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Fitzner, R. E., S. G. Weiss, and J. A. Stegen, 1994, *Biological Assessment for Threatened and Endangered Wildlife Species*, WHC-EP-0513, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Fitzner, R. E., S. G., Weiss, and J. A. Stegen, 1994, *Threatened and Endangered Wildlife Species of the Hanford Site Related to CERCLA Characterization Activities*, WHC-EP-0513, Westinghouse Hanford Company, Richland, Washington.

Landeen, D. S., M. R. Sackschewsky, and S. G. Weiss, 1993, *100 Areas CERCLA Ecological Investigations*, 1993, WHC-EP-0620, Westinghouse Hanford Company, Richland, Washington.

Relander, C., 1986, *Drummers and Dreamers*, Caxton Printers, Ltd., Seattle, Washington (reprint of 1956 ed.).

Rogers, L. E. and W. H. Rickard, 1977, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*, PNL-2253, Pacific Northwest Laboratory, Richland, Washington.

Rice, D. G., 1980, *Overview of Cultural Resources on the Hanford Reservation in South Central Washington State*, Report submitted to U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Rice, D. G., 1968, *Archaeological Reconnaissance: Hanford Atomic Works*, U.S. Atomic Energy Commission, National Park Service and Washington State University, Pullman, Washington.

Sackschewsky, M. R. and D. S. Landeen, 1992, *Fiscal Year 1992 100 Areas CERCLA Ecological Investigations*, WHC-EP-0448, Westinghouse Hanford Company, Richland, Washington.

Stegen, J. A., 1992, *Biological Assessment for State Candidates and Monitored Wildlife Species Related to CERCLA*, WHC-SD-EN-TI-009, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Stegen, J. A., 1994, *Vegetation Communities Associated with the 100 Area and 200 Area Facilities on the Hanford Site*, WHC-SD-EN-TI-216, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Weiss, S. and R. M. Mitchell, 1992, *A Synthesis of Ecological Data from the 100 Areas of the Hanford Site*, WHC-EP-0601, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *Qualitative Risk Assessment of the 100-KR-1 Source Operable Unit*, WHC-SD-EN-RA-009, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994a, *100-K Area Technical Baseline Report*, WHC-SD-EN-TI-239, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *100 Areas Source Operable Unit Focused Feasibility Study Cost Models*, WHC-SD-EN-TI-286, Westinghouse Hanford Company, Richland, Washington.

Wright, Mona K, 1993, *Fiscal Year 1992 Report on Archaeological Surveys of the 100 Areas, Hanford Site*, PNL-8819, Pacific Northwest Laboratory, Richland, Washington.

ATTACHMENT 1

100-KR-1 OPERABLE UNIT WASTE-SITE VOLUME ESTIMATES

OBJECTIVE:

Provide estimates of:

- The volume of contaminated materials within selected waste sites in the 100-KR-1 Operable Unit.
- The volume of materials which will need to be excavated to remove the contaminated materials.
- The areal extent of contamination.

Estimates are provided for the following waste sites:

Site Number	Site Name
116-K-1	116-K-1 Crib
116-K-2	116-K-2 Process Effluent Trench
116-KW-3	107-KW Retention Basins
116-KE-4	107-KE Retention Basins
100-KR-1	Buried Process Effluent Pipelines

METHOD:

The following steps are used to calculate volumes and areas for each waste site:

- Estimate the dimensions of each waste site
- Estimate the location of the site
- Estimate the extent of contamination present at each site
- Estimate the extent of the excavation necessary to remove the contamination present
- Calculate the volume of contamination present, the volume of material to be removed, and the areal extent of contamination.

Waste Site Dimensions - Dimensions of the waste site are derived from all pertinent references.

METHOD (continued):

Waste Site Location - Location of the waste site is derived from pertinent references. The specific reference or method used to locate each site is discussed in a separate brief (see references 6, 7, 8, 9, and 10). Coordinates for each waste site are converted to Washington State coordinates (see references 6, 7, and 10). Resulting Washington State coordinates are presented herein.

Contaminated Volume Dimensions - The extent of contamination present at the waste site is estimated from analytical data which exists for the site. The data used, assumptions made, and method for estimating extent are discussed in a separate brief (see references 6, 7, 8, and 9). Dimensions are summarized herein.

Excavated Volume Dimensions - The extent of the excavation necessary to remove the contamination is based on a 1.5 H:1.0 V excavation slope with the extent of contamination at depth serving as the bottom of the excavation.

Volume and Area Calculations - The above information is used to construct a digital terrain model of each site within the computer program AutoCad. The computer program Digital Terrain Modeling[1] and Earthworks[2] Modules are then used to calculate volumes and areas for the waste site.

ASSUMPTIONS:

The following assumptions were used to locate and/or provide dimensions for a waste site if no other data exists. See references 5, 6, 7, 8, and 9 for assumptions concerning extent of contamination.

The following assumptions were used in calculation volumes and areas:

- No site interferences or overlaps are considered; volumes and areas are calculated for each waste site separately

- All depths are below grade unless otherwise noted.

[1]Digital Terrain Modeling is a tradename of Softdesk, Inc.

[2]Earthworks is a tradename of Softdesk, Inc.

REFERENCES:

1. Dorian, J. J. and V. R. Richards, 1978, *Radiological Characterization of the Retired 100 Areas* and *Field Logs,* UNI-946, United Nuclear Industries, Richland, Washington.

2. DOE-RL, 1994, *Limited Field Investigation Report for the 100-KR-1 Operable Unit,* DOE/RL-93-78, Draft A, Department of Energy, Richland Operations Office, Richland, Washington.

3. DOE-RL, 1993, *Limited Field Investigation Report for the 100-KR-4 Operable Unit,* DOE/RL-93-79, Draft A, Department of Energy, Richland Operations Office, Richland, Washington.

4. IT Corporation, 1994a, *"116-K-1 Crib Basin Contamination Volume Estimate, Rev. 1,* IT Corporation, Calculation Brief, Project Number 199806.418.

5. IT Corporation, 1994b, *116-K-2 Trench Contamination Volume Estimate, Rev. 1,* IT Corporation, Calculation Brief, Project Number 199806.418.

6. IT Corporation, 1994c, *107-KW Retention Basin Contamination Volume Estimate, Rev. 1,* IT Corporation, Calculation Brief, Project Number 199806.418.

7. IT Corporation, 1994d, *107-KE Retention Basin Contamination Volume Estimate, Rev. 1,* IT Corporation, Calculation Brief, Project Number 199806.418.

8. IT Corporation, 1994e, *107-KE and -KW Retention Basin Coordinate Calculations, Rev. 1,* IT Corporation, Calculation Brief, Project Number 199806.418.

9. IT Corporation, 1994f, *K Area Pipeline Lengths*, Calculation Brief, Project Number 199806.418.

10. IT Corporation, 1994g, *K Area Pipeline Depths*, Calculation Brief, Project Number 199806.418.

11. IT Corporation, 1994h, *100-KR-1 Process Pipeline Volume Estimate*, Calculation Brief, Project 199806.418.

SITE NUMBER: 116-K-1
SITE NAME: 116-K-1 Crib

WASTE SITE DIMENSIONS: (DOE-RL 1994)

Crib consists of a flat inner area, elevation 126 m, surrounded by earthen embankment 6.096 m high, elevation 132 m.
Length of inner area - 60.96 m (200 ft)
Width of inner area - 60.96 m (200 ft)
Length of embankment 121.9 m (400 ft)
Width of embankment 121.9 m (400 ft)
Height of embankment - 6.096 m (20 ft)
Orientation - Corners of crib aligned North-South and East-West

CONTAMINATED VOLUME DIMENSIONS: (IT Corporation 1994a)

The extent of contamination is represented by 126.5 m topographic contour on the inner slope of the embankment.

Length - ~60.96 m (200 ft) [estimated from attached figure]
Width - ~60.96 m (200 ft) [estimated from attached figure]
Depth - 1.83 m (6 ft)

EXCAVATED VOLUME DIMENSIONS: (IT Corporation 1994a)

Base of excavation is 60.96 m (200 ft) by 60.96 m (200 ft) at a depth of 1.83 m (6 ft) [attached figure]. Top of excavation dimension is 69.26 m (227 ft) by 69.26 m (227 ft). See attached figure for excavation top dimensions.

Excavation Slopes 1.5 H : 1.0 V

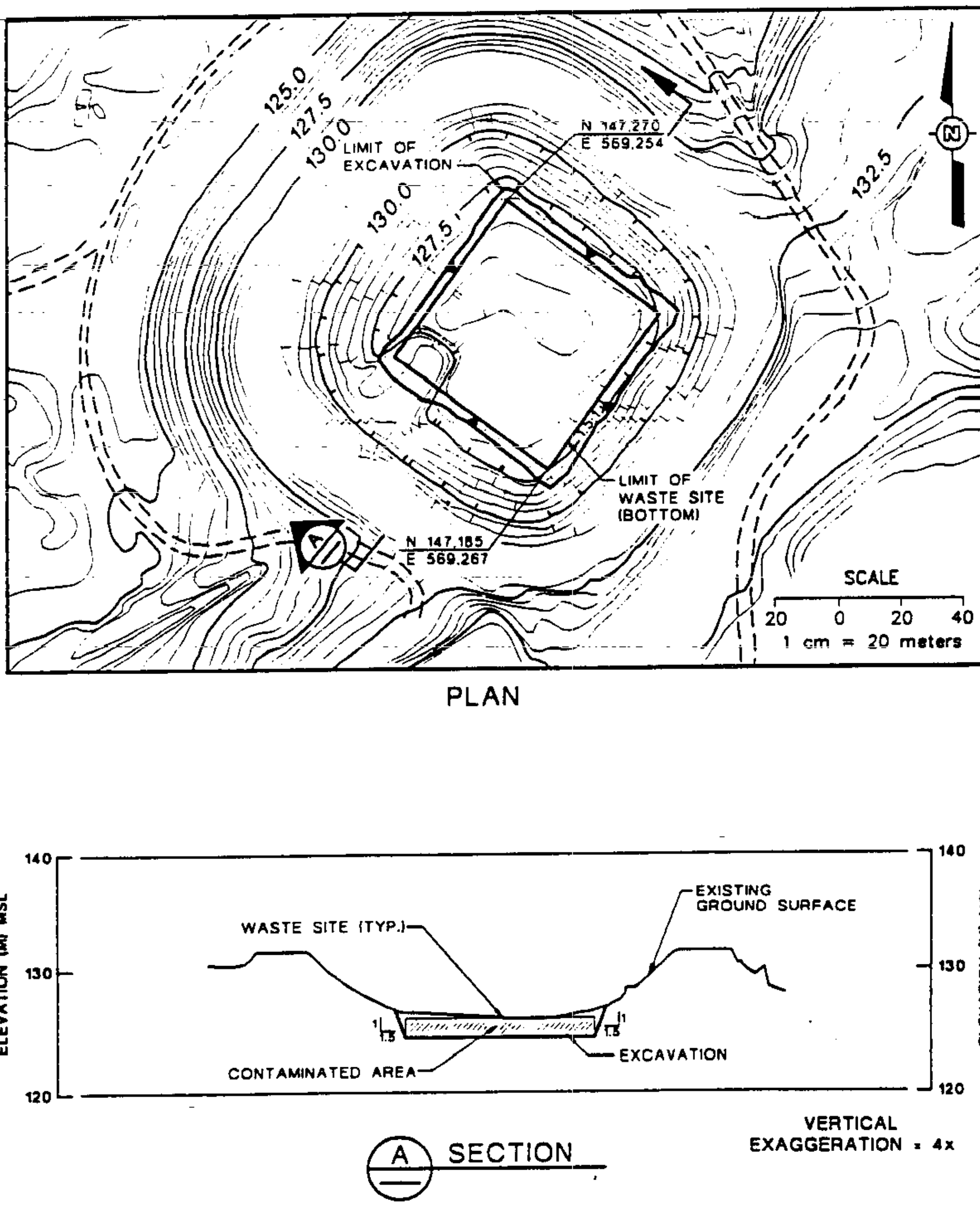
WASTE SITE LOCATION:

N 147,270 E 569,254
Reference Point: North Corner of Crib Interior [see attached figure]

ELEVATIONS:

Surface: 126 m (413 ft) [see attached figure]
Groundwater: 118.41 m (388.4 ft) (DOE-RL 1993)

Figure MA1-1. 116-K-1 Crib.



EXTENT OF CONTAMINATION

SURFACE AREA = 3,716 sq. meters
VOLUME = 6,800 cu. meters

EXTENT OF EXCAVATION

SURFACE AREA = 4,797 sq. meters
VOLUME = 7,870 cu. meters

116K1

SITE NUMBER: 116-K-2
SITE NAME: 116-K-2 Process Effluent Trench

WASTE SITE DIMENSIONS: (DOE-RL 1994; IT Corporation 1994b)

Trench bottom was 5.33 m (17.5 ft) below grade of 131.06 m (430 ft) and surrounded by embankments 2.29 m high.

Length of trench - 1249.7 m (4100 ft)
Width of trench - 13.7 m (45 ft)
Depth of trench - 7.62 m (25 ft) top of embankment to bottom of trench
Orientation - Trench axis aligned northeast with inlet at southwest end

CONTAMINATED VOLUME DIMENSIONS: (IT Corporation 1994b, Dorian and Richards, 1978)

Extent of contamination defined by trench outline and area beyond of trench, extending 67.1 m (220 ft) from trench axis to borehole "V." See figure.

Length of trench - ~1249.7 m (4100 ft) [estimated from attached figure]
Width of trench - ~13.7 m (45 ft) [estimated from attached figure]
Depth of contamination - 7.6 m (25 ft)
Length of radius of contaminated area outside trench - 67.06 m (220 ft)
Depth of contamination outside trench - 0.6096 m (2 ft)

EXCAVATED VOLUME DIMENSIONS: (IT Corporation 1994b)

Base of excavation is 1249.7 m (4100 ft) by 13.7 m (45 ft) at a depth of 7.62 m (25 ft) [see attached figure]. Estimated top of excavation dimensions for trench are 1273.4 m (4178 ft) by 37.5 m (123 ft) and for semicircular area outside the trench is a radius of 68.06 m (223 ft). See attached figure for excavation top dimensions.

Excavation Slopes 1.5 H : 1.0 V

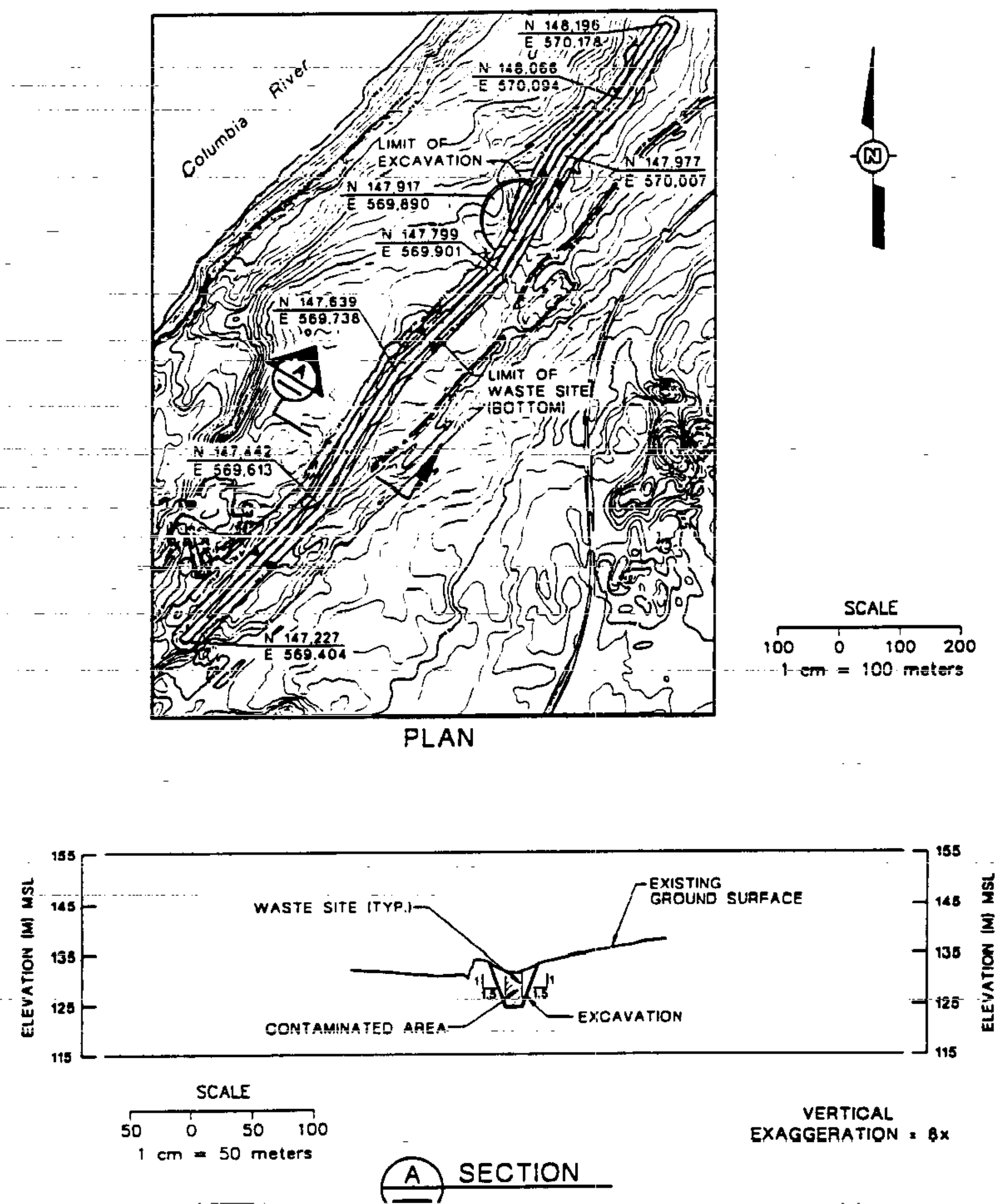
WASTE SITE LOCATION:

N 147,227 E 569,404
Reference Point: Southwest Corner of Trench [see attached figure]

ELEVATIONS: (DOE-RL 1993)

Surface: 132 m (433 ft) [see attached figure]
Groundwater: 118.41 m (388.6 ft)

Figure MA1-2. 116-K-2 Process Effluent Trench.



EXTENT OF CONTAMINATION

SURFACE AREA = 21,625 sq. meters
VOLUME = 133,237 cu. meters

EXTENT OF EXCAVATION

SURFACE AREA = 58,030 sq. meters
VOLUME = 289,166 cu. meters

116K2

SITE NUMBER: 116-KW-3
SITE NAME: 107-KW Retention Basins

WASTE SITE DIMENSIONS: (DOE-RL 1994)

Number of Tanks - 3
Diameter - 76.2 m (250 ft)
Height - 8.84 m (29 ft)
Orientation - Northeast-Southwest, axis through center of the three tanks

CONTAMINATED VOLUME DIMENSIONS: (IT Corporation 1994c)

The extent of contamination was controlled by topography to the southeast (135 m [443 ft] topographic elevation line), northeast (drainage ditch on the far side of the road bed) and southwest (drainage ditch on the far side of the road bed). To the northwest the contamination extent was controlled by the farthest contaminated testpit.

Length - ~286 m (938 ft) [estimated from attached figure]
Width - ~160 m (525 ft) [estimated from attached figure]
Depth - 6.02 m (20 ft)

EXCAVATED VOLUME DIMENSIONS: (IT Corporation 1994c)

Base of excavation is 286 m (938 ft) by 160 m (525 ft) at a depth of 6.02 m (20 ft) [attached figure]. See attached figure for excavation top dimensions.

Excavation Slopes 1.5 H : 1.0 V

WASTE SITE LOCATION: (IT Corporation 1994c; 1994e)

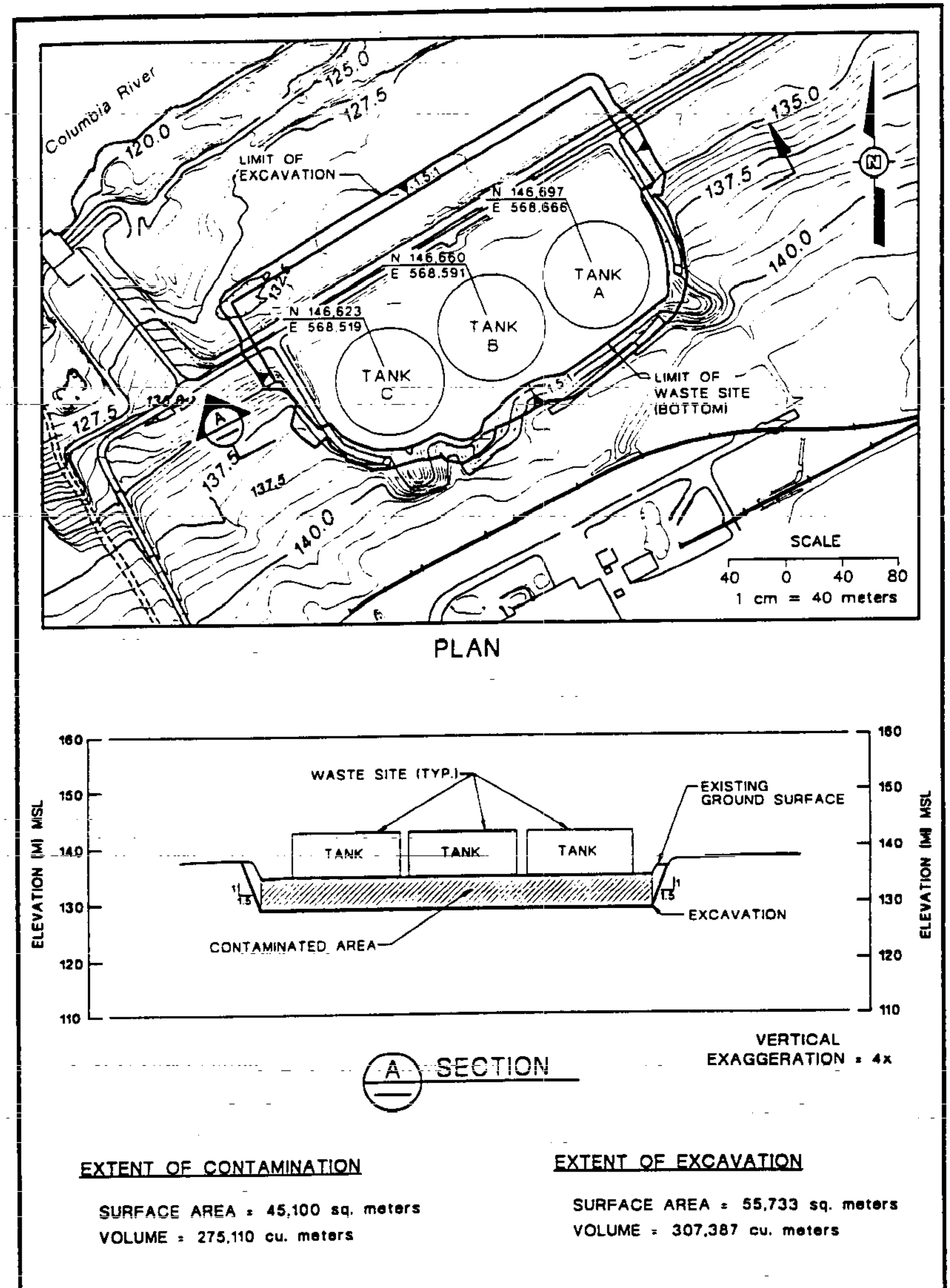
Tank A: N 146,697 E 568,666
Tank B: N 146,660 E 568,591
Tank C: N 146,623 E 568,519

Reference Point: Center of each tank

ELEVATIONS: (DOE-RL 1993)

Surface: 135.02 m (443 ft) [attached figure]
Groundwater: 118.87 m (390 ft)

Figure MA1-3. 116-KW-3 Retention Basins.



107KW

SITE NUMBER: 116-KE-4
SITE NAME: 107-KE Retention Basins

WASTE SITE DIMENSIONS: (DOE-RL 1994)

Number of Tanks - 3
Diameter - 76.2 m (250 ft)
Height - 7.6 m (25 ft)
Orientation - Northeast-Southwest, axis through center of the three tanks

CONTAMINATED VOLUME DIMENSIONS: (IT Corporation 1994d)

The extent of contamination was controlled by topography; to the southeast by the 137.5 m (451 ft) topographic elevation line, to the northeast and southwest by the drainage ditch on the far side of the road bed, and to the northwest by the drainage ditch running approximately parallel to the site axis.

Length - ~286 m (938 ft) [estimated from attached figure]
Width - ~183 m (600 ft) [estimated from attached figure]
Depth - 3.04 m (10 ft)

EXCAVATED VOLUME DIMENSIONS: (IT Corporation 1994d)

Base of excavation is 286 m (938 ft) by 183 m (600 ft) at a depth of 3.04 m (10 ft) [attached figure]. See attached figure for excavation top dimensions.

Excavation Slopes 1.5 H : 1.0 V

WASTE SITE LOCATION: (IT Corporation 1994c; 1994e)

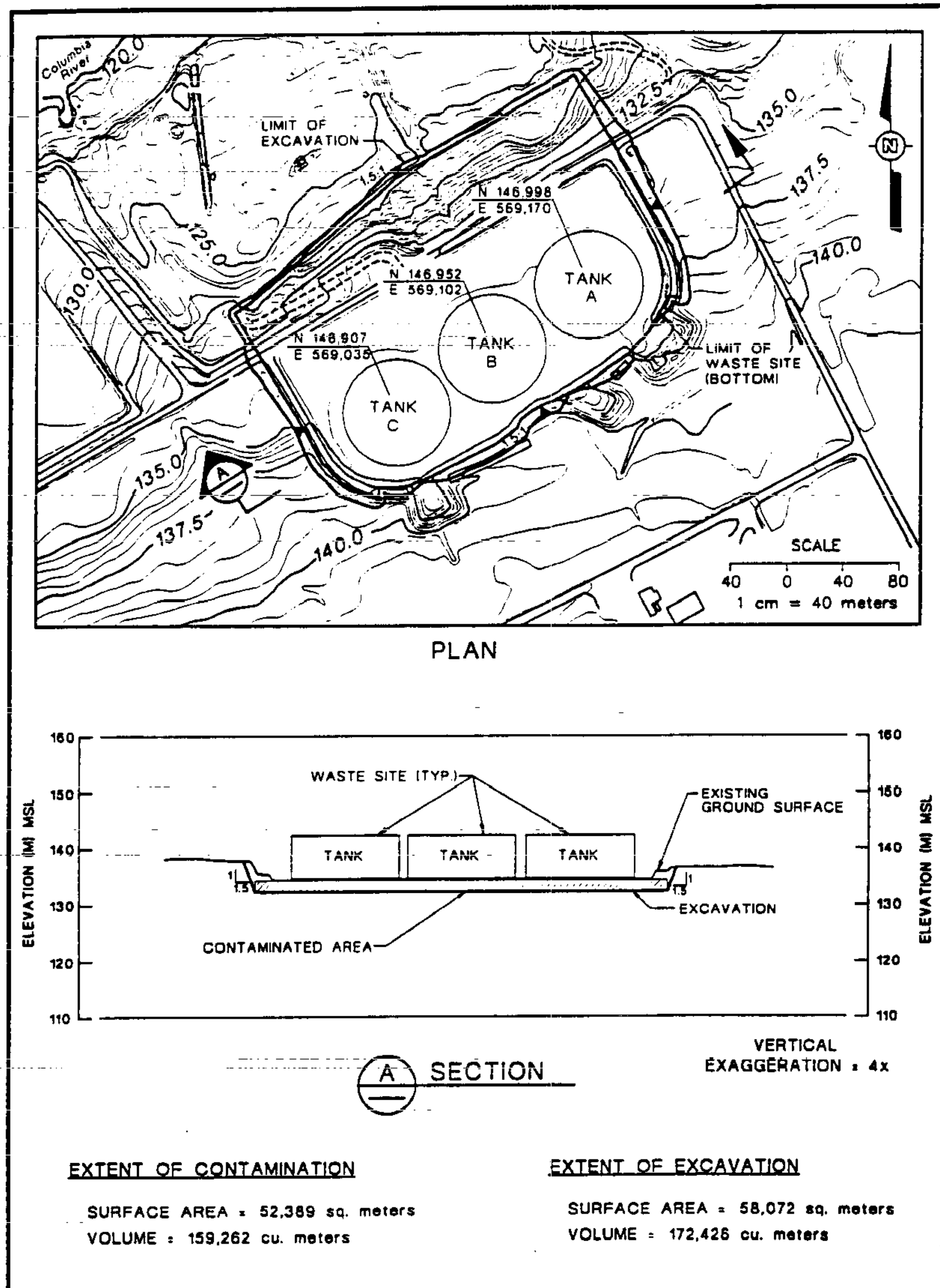
Tank A:	N 146,998 E 569,170
Tank B:	N 146,952 E 569,102
Tank C:	N 146,907 E 569,305

Reference Point: Center of each tank

ELEVATIONS: (DOE-RL 1993)

Surface: 135.03 m (443 ft) [attached figure]
Groundwater: 118.87 m (390 ft)

Figure MA1-4. 116-KE-4 Retention Basins.



107KE

SITE NUMBER: NA
SITE NAME: 100-KR-1 Buried Process Effluent Pipelines

WASTE SITE DIMENSIONS: (IT Corporation 1994f; 1994g; DOE-RL 1994)

Length - 2805 ft (855 m)
Width - 6 ft (1.8 m)
Depth - Varies
Slopes - Varies
Orientation - Varies

Length - 255 ft (77.7 m)
Width - 5 ft (1.5 m)
Depth - Varies
Slopes - Varies
Orientation - Varies

Length - 1169 ft (356.3 m)
Width - 3 ft (0.9 m)
Depth - Varies
Slopes - Varies
Orientation - Varies

Length - 1065 ft (324.6 m)
Width - 5.5 ft (1.7 m)
Depth - Varies
Slope - Varies
Orientation - Varies

Length - 3973 ft (1211 m)
Width - 3.5 ft (1.1 m)
Depth - Varies
Slope - Varies
Orientation - Varies

Length - 826 ft (251.8 m)
Width - 1 ft (0.3 m)
Depth - Varies
Slope - Varies
Orientation - Varies

CONTAMINATED VOLUME DIMENSIONS:

Soil around pipe- No contamination along length of pipe.

Sludge inside pipe- All pipes have contaminated sludge along bottom. Volume of sludge is insignificant, the volume calculated will be that of pipe void.

EXCAVATED VOLUME DIMENSIONS: (IT Corporation 1994h)

Depends on depth of pipe. Base of excavation is 2 ft (0.6 m) on each side of the pipe and begins 3 inches below invert of pipe.

Excavation Slopes 1.5 H : 1.0 V

WASTE SITE LOCATION:

See figure.

ELEVATIONS:

See figure.

Figure MA1-5. 100-KR-1 Buried Process Effluent Pipelines.

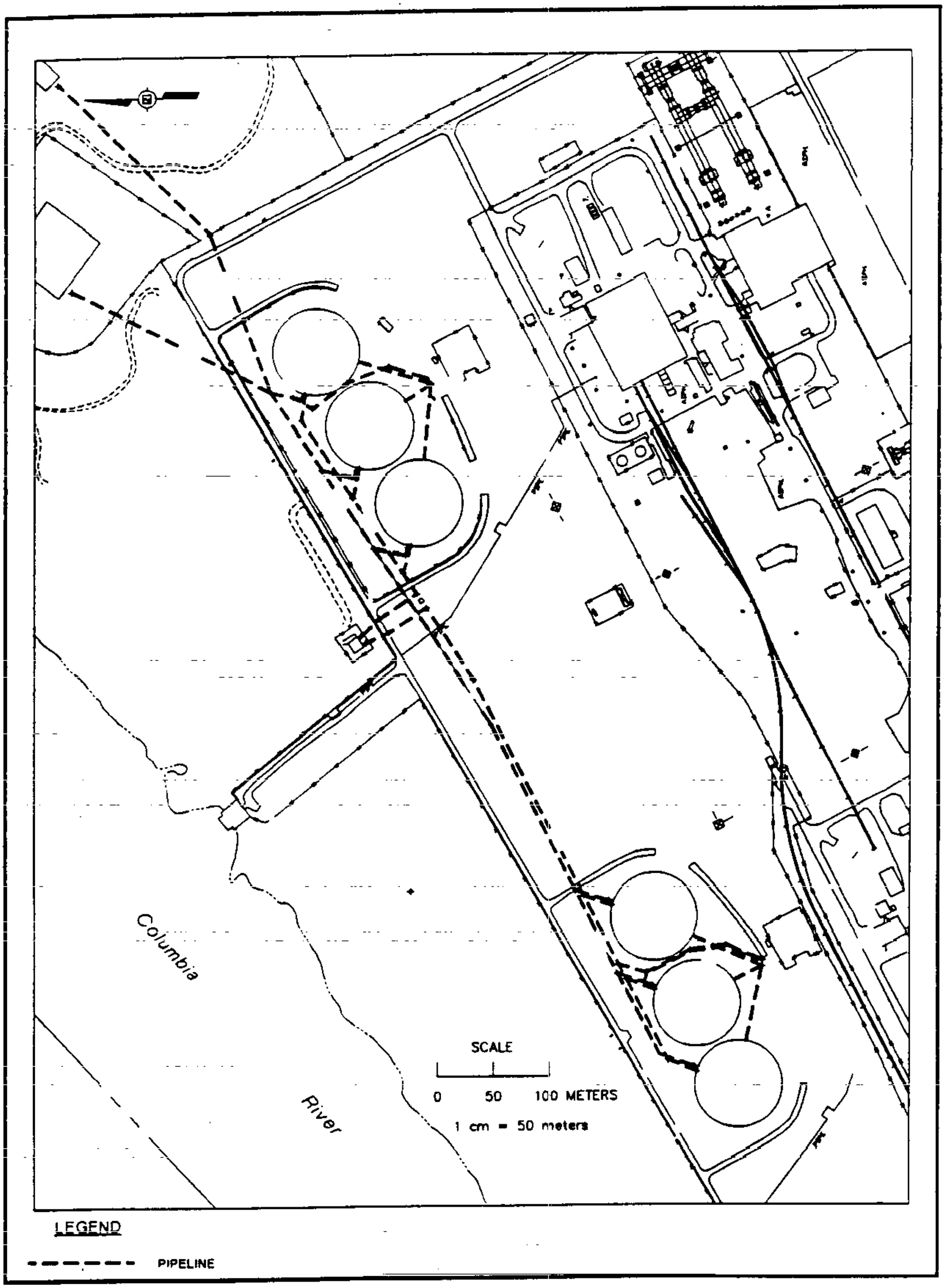


Figure MA1-6. Typical Pipeline Excavation Cross Section.

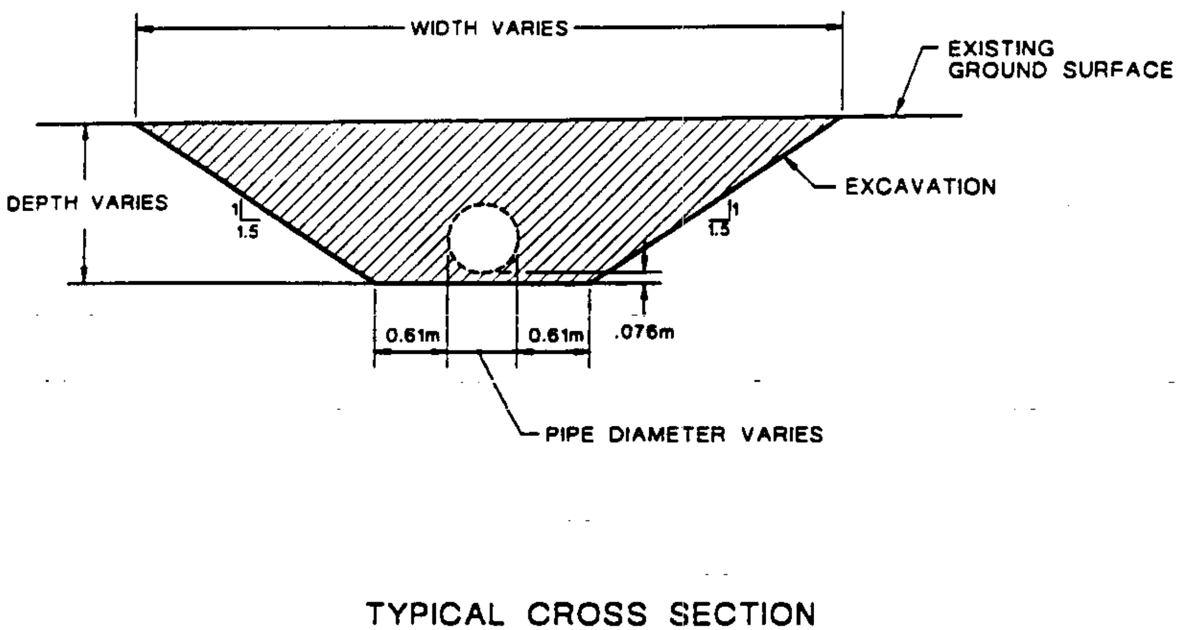
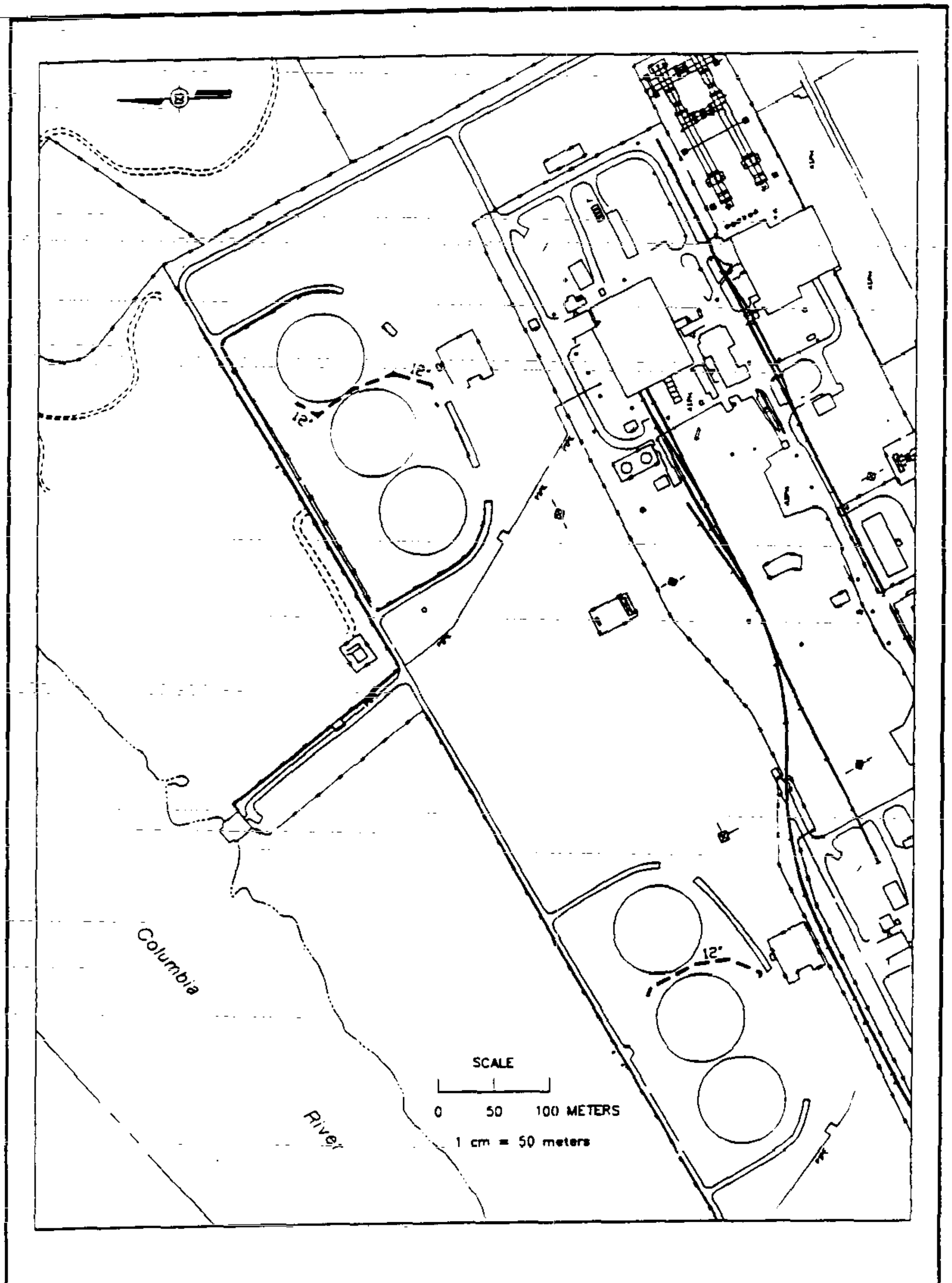
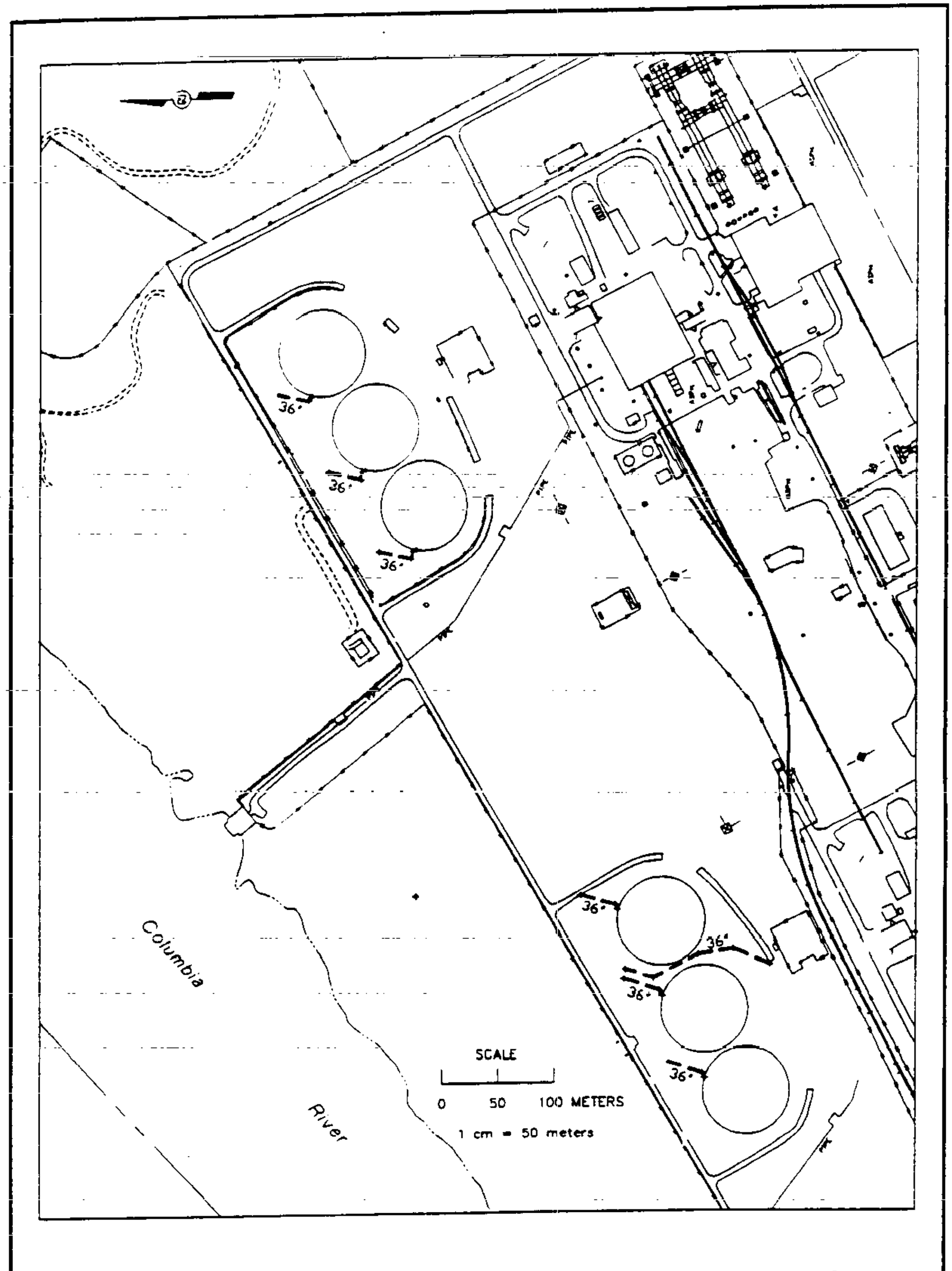


Figure MA1-7. 100-KR-1 12-in. Pipelines.



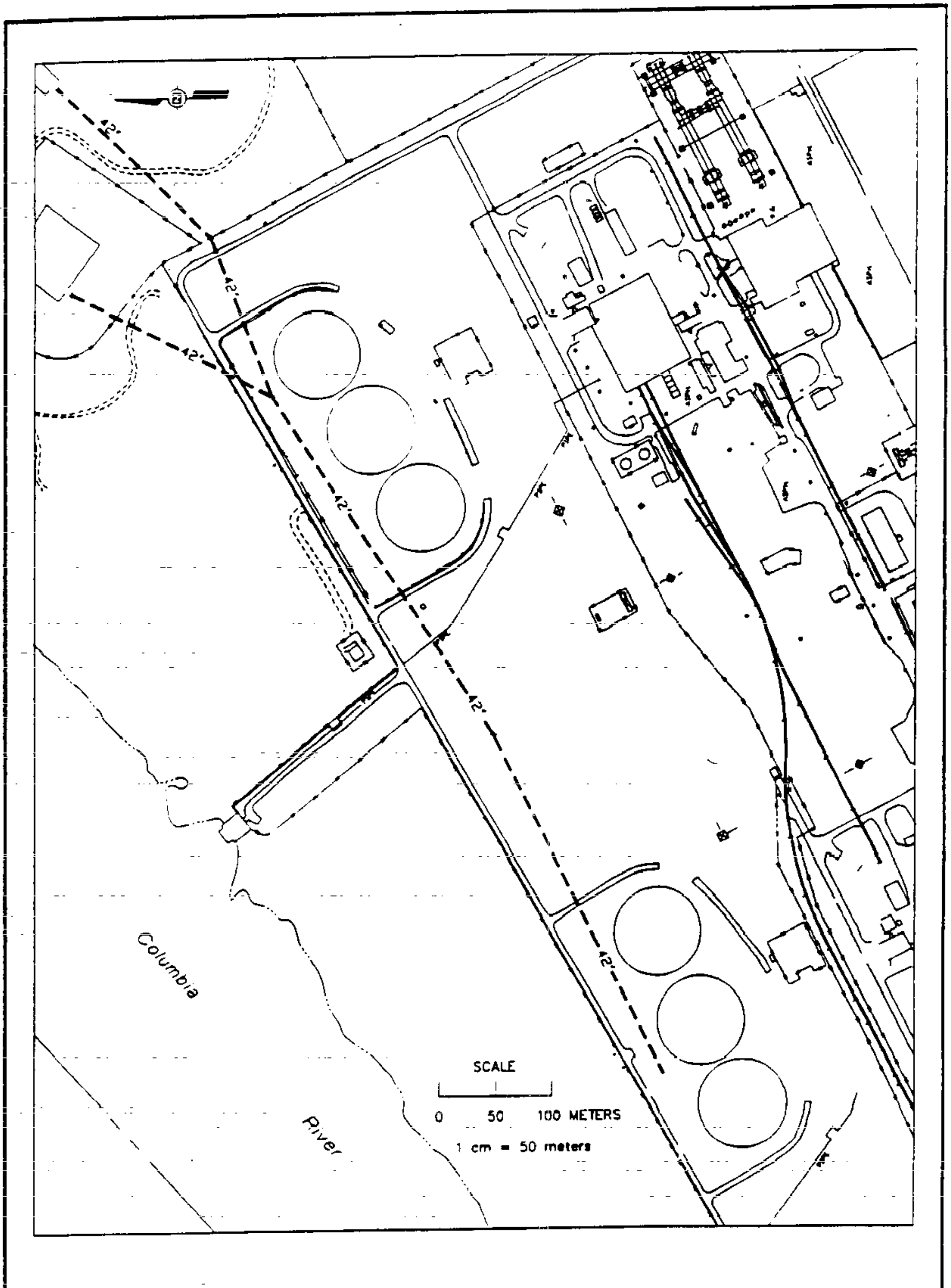
12INCH

Figure MA1-8. 100-KR-1 36-in. Pipelines.



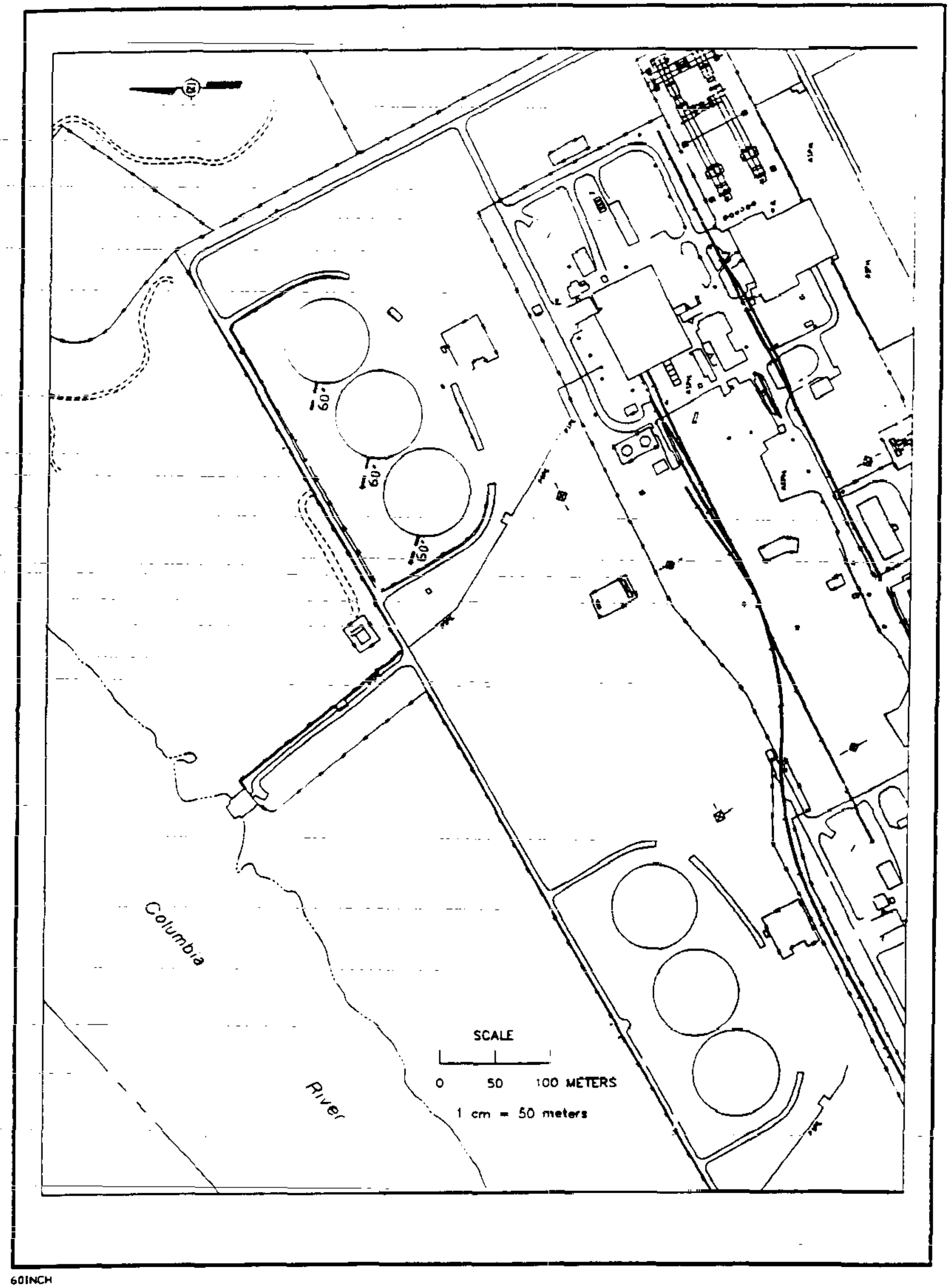
36INCH

Figure MA1-9. 100-KR-1 42-in. Pipelines.



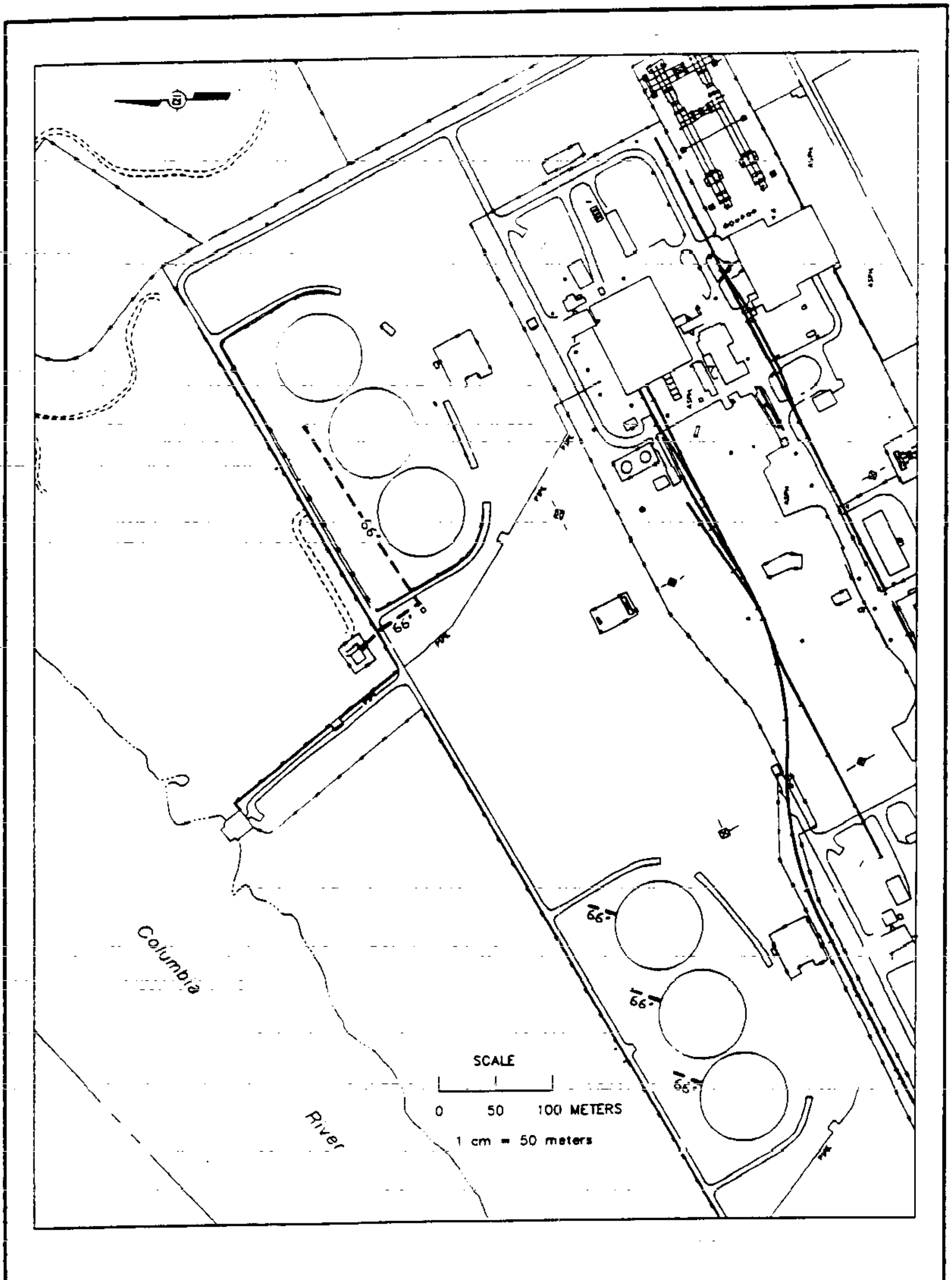
42INCH

Figure MA1-10. 100-KR-1 60-in. Pipelines.



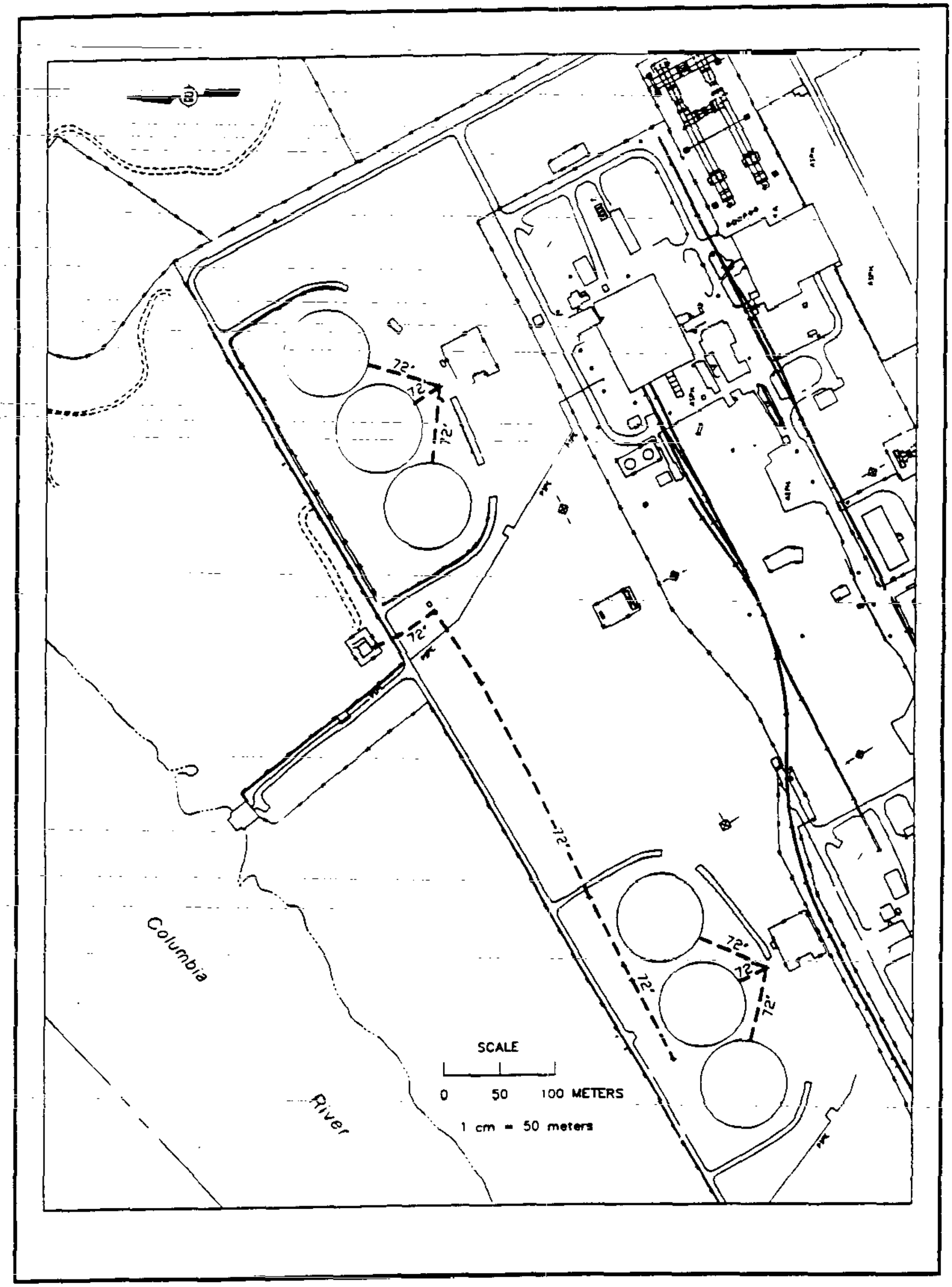
60INCH

Figure MA1-11. 100-KR-1 66-in. Pipelines.



66INCH

Figure MA1-12. 100-KR-1 72-in. Pipelines.



ATTACHMENT 2

100-KR-1 OPERABLE UNIT WASTE-SITE COST ESTIMATES

1.0 COST ESTIMATE SUMMARIES

This appendix has two primary purposes. The first describes the cost models developed to support the source operable unit FFS reports. The second documents the cost estimates developed for each waste site using the cost models.

1.1 DESCRIPTION OF COST MODELS

A cost model defines the remedial alternative activities and provides a method in which to estimate the associated cost. Each cost model is developed using the Micro Computer Aided Cost Estimating System (MCACES) software package.

The FFS cost models are based on the Environmental Restoration cost models used to develop the fiscal year planning baselines. The Environmental Restoration cost models were modified for the source operable unit FFS to include all costs associated with the remedial alternatives. Project Time and Cost, Inc., supported both the baseline and FFS cost estimating activities. The 14 cost models associated with the source operable unit FFS are presented in the *100 Areas Source Operable Unit Focused Feasibility Study Cost Models* (WHC 1994b).

All cost models were developed based on a common work breakdown structure. There are three main elements within the structure: Offsite Analytical Services (ANA), Fixed Price Contractor (SUB), and Westinghouse Hanford Company (WHC)[1]. Each element is defined further by additional levels.

1.2 WASTE-SITE COST ESTIMATES

Cost estimates were developed for each waste site addressed by the FFS based on the applicable cost model. The present worth for each estimate is based on a 5% discount rate and a disposal fee of $\$70/yd^3$. The cost comparison between the various applicable alternatives for each waste site are presented in Tables MA2-1 through MA2-5.

[1]The cost model terminology has not been updated to reflect the current change in the environmental restoration primary contractor.

Table MA2-1. Cost Summary for 116-K-1 Crib.

Cost Element		SS-3	SS-4	SS-8A	SS-10
ANA: Offsite Analytical Services					
ANA:02	Monitoring, Sampling, & Analysis	-	109,460	-	109,460
SUB: Fixed Price Contractor					
SUB:01	Mobilization & Preparatory	80,750	58,000	56,350	58,000
SUB:02	Monitoring, Sampling, & Analysis	-	26,200	2,350	26,200
SUB:08	Solids Collection & Containment	2,046,780	43,910	12,760	43,910
SUB:13	Physical Treatment	-	-	-	-
SUB:14	Thermal Treatment	-	-	-	-
SUB:15	Stabilization/Fixation	-	-	6,369,810	-
SUB:18	Disposal (Other than Commercial)	-	1,130,460	-	1,130,460
SUB:20	Site Restoration	1,356,110	183,450	115,260	183,450
SUB:21	Demobilization	14,700	14,580	14,750	14,580
WHC: Westinghouse Hanford Company					
WHC:02	Monitoring, Sampling, & Analysis	122,700	64,860	617,130	64,860
WHC:08	Solids Collection & Containment	6,750	4,570	101,280	4,570
Subcontractor Materials Procurement Rate		255,380	106,330	65,710	106,330
Project Management/Construction Management		582,480	244,850	1,103,310	244,850
General & Administration/Common Support Pool		1,138,740	478,690	2,156,970	478,690
Contingency		1,905,490	838,220	3,609,330	838,220
Total		7,509,880	3,303,580	14,225,010	3,303,580
Capital		7,509,880	3,303,580	7,988,530	3,303,580
Total Operations & Maintenance		2,353,797	0	6,236,480	0
Present Worth		8,470,900	3,149,090	13,550,582	3,149,090

SS-3: Containment
SS-4: Removal/Disposal
SS-8A: In Situ Treatment
SS-10: Removal/Treatment/Disposal

Table MA2-2. Cost Summary for 116-K-2 Process Effluent Trench.

Cost Element		SS-4	SS-10
ANA: Offsite Analytical Services			
ANA:02	Monitoring, Sampling, & Analysis	2,163,940	3,254,330
SUB: Fixed Price Contractor			
SUB:01	Mobilization & Preparatory	191,430	197,160
SUB:02	Monitoring, Sampling, & Analysis	888,430	1,239,530
SUB:08	Solids Collection & Containment	1,440,740	1,628,450
SUB:13	Physical Treatment	-	9,873,640
SUB:14	Thermal Treatment	-	-
SUB:15	Stabilization/Fixation	-	-
SUB:18	Disposal (Other than Commercial)	24,972,140	17,322,750
SUB:20	Site Restoration	3,790,210	3,279,890
SUB:21	Demobilization	33,300	33,290
WHC: Westinghouse Hanford Company			
WHC:02	Monitoring, Sampling, & Analysis	2,100,660	2,971,340
WHC:08	Solids Collection & Containment	166,360	246,200
Subcontractor Materials Procurement Rate		313,160	335,750
Project Management/Construction Management		5,084,470	5,569,200
General & Administration/Common Support Pool		9,940,130	10,887,790
Contingency		17,368,900	21,030,550
Total		68,453,870	77,869,870
Capital		68,453,870	68,153,130
Total Operations & Maintenance		0	9,716,740
Present Worth		63,394,471	71,140,252

SS-4: Removal/Disposal
SS-10: Removal/Treatment/Disposal

Table MA2-3. Cost Summary for 116-KW-3 Retention Basins.

Cost Element		SS-3	SS-4	SS-10
ANA: Offsite Analytical Services				
ANA:02	Monitoring, Sampling, & Analysis	-	1,300,890	3,237,490
SUB: Fixed Price Contractor				
SUB:01	Mobilization & Preparatory	113,810	95,876	86,320
SUB:02	Monitoring, Sampling, & Analysis	-	481,348	1,320,690
SUB:08	Solids Collection & Containment	15,966,700	1,100,689	1,597,340
SUB:13	Physical Treatment	-	-	27,557,760
SUB:14	Thermal Treatment	-	-	-
SUB:15	Stabilization/Fixation	-	-	-
SUB:18	Disposal (Other than Commercial)	-	38,108,327	17,948,360
SUB:20	Site Restoration	1,829,760	3,838,375	2,894,160
SUB:21	Demobilization	19,340	18,742	16,860
WHC: Westinghouse Hanford Company				
WHC:02	Monitoring, Sampling, & Analysis	897,190	1,026,840	3,123,060
WHC:08	Solids Collection & Containment	52,550	104,461	357,000
Subcontractor Materials Procurement Rate		179,300	436,434	514,220
Project Management/Construction Management		2,858,800	6,781,664	8,312,370
General & Administration/Common Support Pool		5,588,950	13,258,153	16,250,670
Contingency		9,352,170	23,958,647	30,790,030
Total		36,858,570	90,510,446	114,006,330
Capital		36,858,570	90,510,446	86,582,850
Total Operations & Maintenance		17,563,370	0	27,423,480
Present Worth		43,766,348	84,929,019	102,586,487
SS-3: Containment SS-4: Removal/Disposal SS-10: Removal/Treatment/Disposal				

Table MA2-4. Cost Summary for 116-KE-4 Retention Basins.

Cost Element		SS-4	SS-8A	SS-10
ANA: Offsite Analytical Services				
ANA:02	Monitoring, Sampling, & Analysis	1,140,910	-	1,515,600
SUB: Fixed Price Contractor				
SUB:01	Mobilization & Preparatory	110,660	93,660	99,740
SUB:02	Monitoring, Sampling, & Analysis	112,820	6,110	298,280
SUB:08	Solids Collection & Containment	249,910	62,190	356,900
SUB:13	Physical Treatment	-	-	4,985,510
SUB:14	Thermal Treatment	-	-	-
SUB:15	Stabilization/Fixation	-	50,397,740	-
SUB:18	Disposal (Other than Commercial)	8,533,330	-	4,952,220
SUB:20	Site Restoration	1,383,040	957,160	1,226,310
SUB:21	Demobilization	21,550	19,910	19,490
WHC: Westinghouse Hanford Company				
WHC:02	Monitoring, Sampling, & Analysis	258,160	6,336,170	664,910
WHC:08	Solids Collection & Containment	18,990	1,061,370	69,290
Subcontractor Materials Procurement Rate		104,110	515,370	119,380
Project Management/Construction Management		1,618,880	8,917,450	1,918,800
General & Administration/Common Support Pool		3,164,920	17,433,620	3,751,260
Contingency		6,018,210	29,172,250	7,391,740
Total		22,735,490	114,973,00 0	27,369,430
Capital		22,735,490	64,575,260	22,542,490
Total Operations & Maintenance		0	50,397,740	4,826,940
Present Worth		21,658,548	87,598,962	26,071,393
SS-4: Removal/Disposal SS-8A: In Situ Treatment SS-10: Removal/Treatment/Disposal				

Table MA2-5. Cost Summary for 100-KR-1 Buried Process Effluent Pipelines.

Cost Element		SS-3	SS-4	SS-8B
ANA: Offsite Analytical Services				
ANA:02	Monitoring, Sampling, & Analysis	-	2,239,720	-
SUB: Fixed Price Contractor				
SUB:01	Mobilization & Preparatory	245,760	46,030	27,460
SUB:02	Monitoring, Sampling, & Analysis	-	700,460	-
SUB:08	Solids Collection & Containment	16,379,410	1,223,560	4,045,720
SUB:13	Physical Treatment	-	-	-
SUB:14	Thermal Treatment	-	-	-
SUB:15	Stabilization/Fixation	-	-	-
SUB:18	Disposal (Other than Commercial)	-	12,959,210	-
SUB:20	Site Restoration	1,871,360	2,418,150	-
SUB:21	Demobilization	41,400	10,570	8,530
WHC: Westinghouse Hanford Company				
WHC:02	Monitoring, Sampling, & Analysis	553,240	2,194,500	135,400
WHC:08	Solids Collection & Containment	12,060	154,410	11,790
Subcontractor Materials Procurement Rate		185,380	173,580	40,820
Project Management/Construction Management		2,893,290	2,982,070	640,460
General & Administration/Common Support Pool		5,656,380	5,829,950	1,252,090
Contingency		9,465,020	11,754,240	2,095,170
Total		37,303,300	42,686,450	8,257,440
Capital		37,303,300	42,686,450	8,257,440
Total Operations & Maintenance		18,010,362	0	0
Present Worth		44,578,770	39,777,379	7,865,693

SS-3: Containment
SS-4: Removal/Disposal
SS-8B: In Situ Treatment
SS-10: Removal/Treatment/Disposal